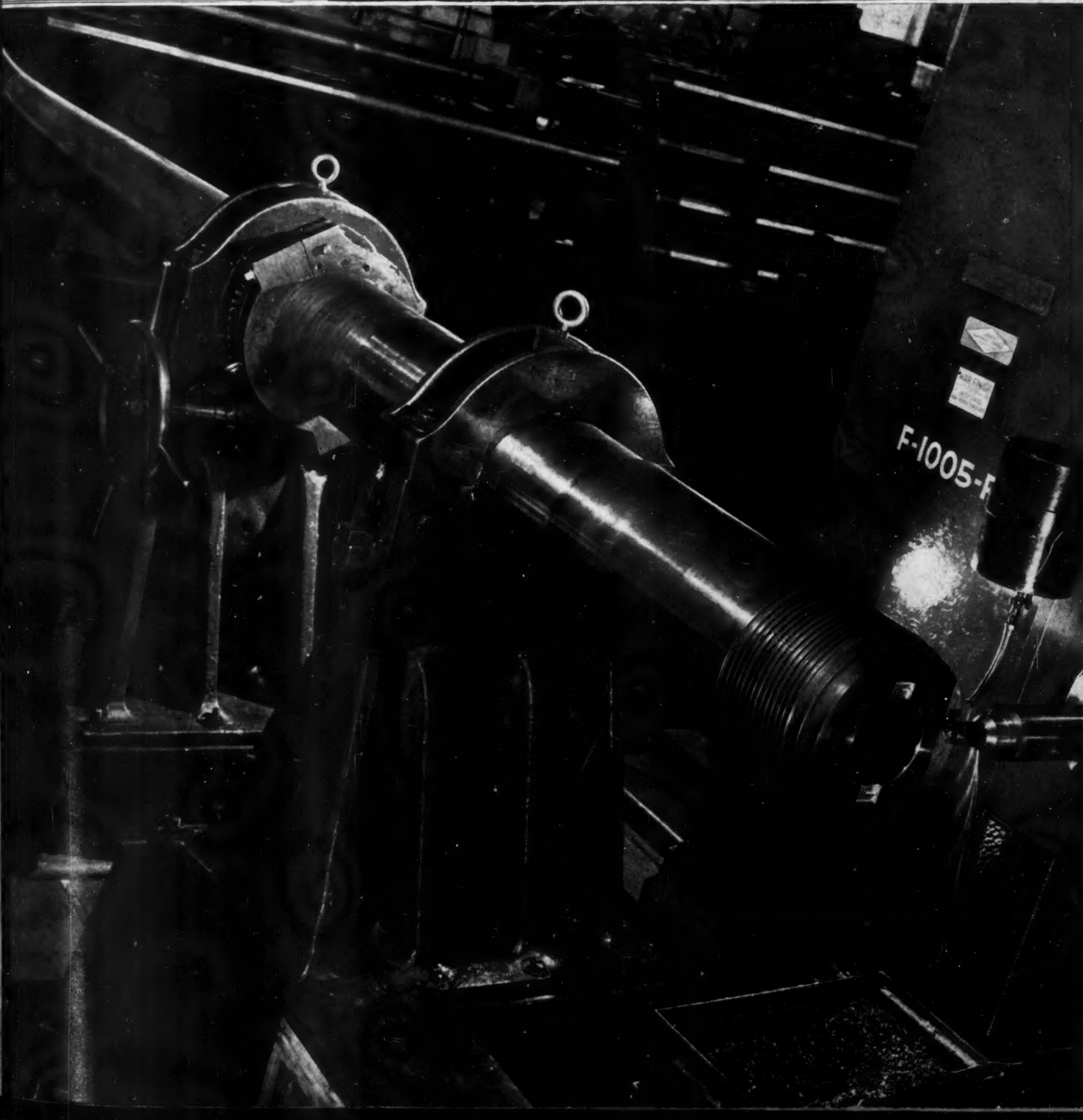
MECHANICAL ENGINEERING

MAY 1944



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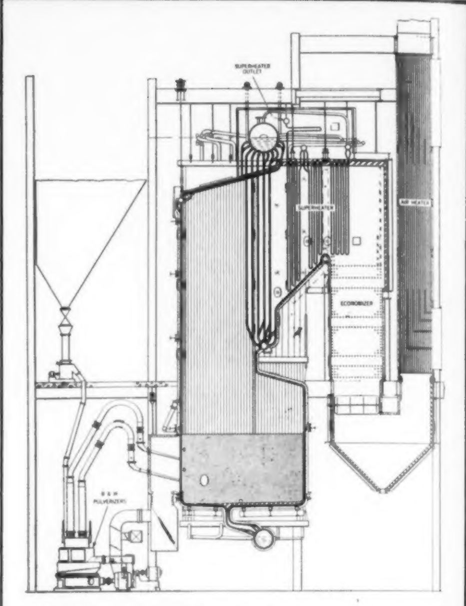

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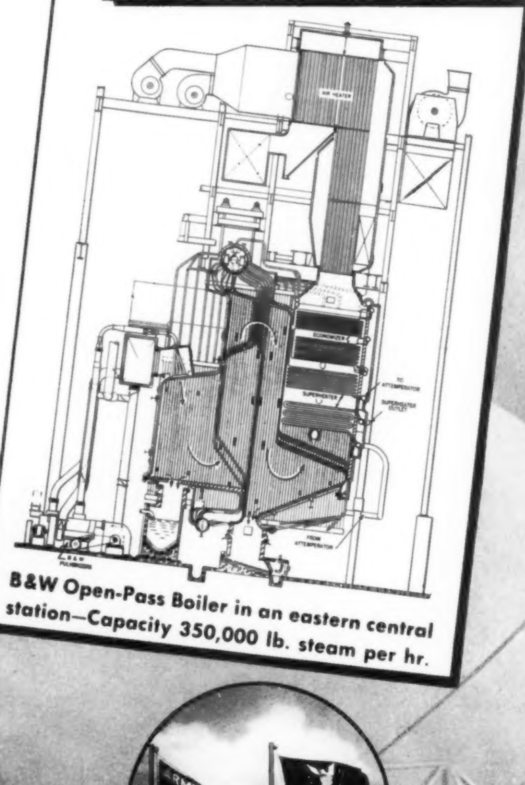

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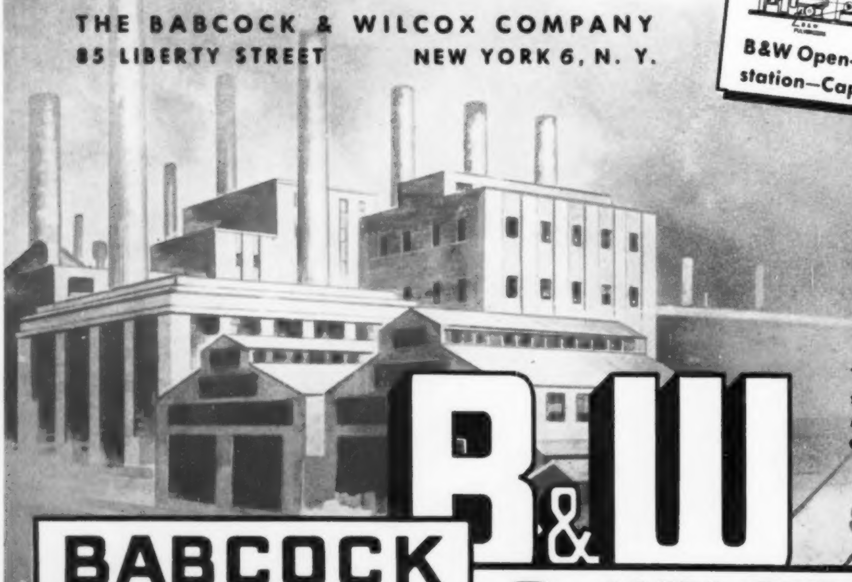

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 66 NUMBER 5

Contents for May, 1944

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price 75 cents a copy, $6.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters two weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . .

Special Electric Motor

(Built by General Electric Company for driving propeller of a small model plane in a large wind tunnel. It is 5 in. diam, 13 in. long, weighs 57 lb, and rated at 30 hp at 6000 rpm. It is water-cooled and can operate at 7000 rpm. The small parts at the right comprise the tachometer assembly which fits into the front end of the motor.)

VOLUME 66
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MECHANICAL ENGINEERING

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1944

GEORGE A. STETSON, *Editor*

Geo. A. Orrok

THERE was an ageless youthfulness and enthusiasm about Geo. A. Orrok, honorary member A.S.M.E., whose death occurred on April 6, that will long be remembered by his friends. One can see him now, coming in to the grill of the Engineers' Club, the tails of his English morning coat aflutter, his step springy and quick as a young man's, his eyes darting keenly around, and the half-smoked cigar in his hand. At table the armchair and the three soft rolls awaited him. Conversation became spirited and dynamic on his arrival; and as more chairs were added to the circle, no subject was too familiar or too remote to escape attention by the inquiring and encyclopedic mind or fail to stir comment, relevant or otherwise. Positive, dictatorial, contentious as his conversation frequently was, it bore conviction and authority; it was never dull, and it was salted with humor, verse, and doggerel that surged from a mind seething with memories and experiences; an orderly storehouse of information, facts, and figures, and odd bits of whimsey forever on tap. When a disputant had been worsted or bludgeoned into silence by the heavy fire of fact or opinion as the occasion required, he would jump headfirst into another conversation with a chuckle of undisguised glee. To the group of companions who egged him on, contradicted him, asked him questions on any and all subjects, twitted him about his cigars or Scotland (Connecticut), riled him by attempting to defend the New Deal or the labor unions, sought to astonish him by announcements of something new in science or engineering (which was inevitably old stuff to him), he was Orrok, the infallible Oracle.

At another time and in another place the biography of Orrok will be set forth. A life so long and so rich in engineering achievements cannot be described in a few paragraphs. First and foremost he was the engineer. There were no qualifying words to describe his type of engineering, although he frequently asserted that "mechanical" included them all. An engineer, according to his definition, was competent in every field. As he said many times, engineering was doing something for the first time—after that it became manufacturing which anyone could do.

On a hot July 3, 1867, in Dorchester, Mass., a town now swallowed up by the sprawling City of Boston, Geo. A. Orrok was born, the son of a New England mechanic whose thrift, ingenuity, and versatility were typical of the town and region. It was in the dawn of a new industrial era when machines and power were being developed and utilized and pioneering in engineering and manufacturing were replacing the colonial way of life already more than two centuries old. For men of Orrok's talents it was a golden era which ushered in the great electric utilities to which he made such outstanding contributions. Behind him was the long line of Scotsmen who bore his name and whose lands lay hidden by the hills whose southern slopes bordered the Firth of Forth. Hardy and independent, they left farm and pasture when the weather moderated in the spring and took to the boats concealed along the shore line to fish, trade, wage war, and plunder and be plundered. Fearless and self-reliant, they were beholden to no man. From father to son the vital spirit of independence passed, modified only by gentler manners in a better organized society but still vigorous, as it was in Orrok, to maintain the rights of the individual, to make one's own way, to resent the encroaching authority of the state, the labor union, and a host of institutions fancied by persons lacking "goods, guts, and gumption."

Taught to use his hands and to handle the tools of the carpenter's and machinist's trades, he augmented skill in these crafts by a canny intelligence and ingenuity. He liked to tell how he discovered the correct way of grinding tools used in tack-making machinery so that, by devoting his time to this function, he was able to hire another boy to feed the machines and thus increase production with an increase in his own wages. During one week spent in Brockton, where he hired out as a carpenter framing roof structures for mills, he got a new job every day, at premium wages, only to be discharged every night because he would not join the union. Thus for him the trade union became the haven of incompetent and lazy workmen and no amount of argument could convince him otherwise. During the closing months of his life he was equally outspoken about "collective bargaining" for engineers, a movement which, in his opinion, might prove to be the twilight of the engineering profession as he knew it.

In a Newcomen address, "Engineering Recollections, 1868–1898," some glimpses of the versatility of the man may be caught. Early learning to use tools of all kinds, he built an equatorial mounting for a telescope with which to observe the transit of Venus, and an iceboat and a dory for use on Dorchester Bay. A grammar-school education, followed by two years at the School of Mechanic Arts, with summers spent working as a molder in a foundry and as a blacksmith in a carriage shop, he continued at M.I.T. where he specialized in chemistry, a college career cut short by ill-health. Newspaper work, prospecting, surveying, teaching, organizing a choir, playing the cornet, panning gold, taking part in amateur dramatics, acting as a railroad brakeman, building wooden bridges, doing the architectural work on a hospital and three schoolhouses, he filled in the years up to 1892 with useful experiences in Alabama, Georgia, Wisconsin, Utah, and Massachusetts and returned to Boston in 1892 to take part,

under Dr. F. S. Pearson, in building the Allston generating station for electric street railways. With Pearson he went to New York to work on cable railways and the design of the underground electric system still used in many of that city's streetcar lines. Thus started a career in the new field of electric power-plant design and construction to which Orrok made so many contributions throughout his long and busy life.

But before the years he spent with the New York Edison Company were to commence there was an interlude of coal-mining experience, which involved piers and docks, coal-loading equipment, mine hoists, collieries, railroading, iron mining, and concrete construction in Nova Scotia and Newfoundland, and the building of street railways, sugar mills, funicular railways, and steam road rollers for the West Indies, South America, and the United States.

The long years of association with the New York Edison Company began under John Van Vleck, when he was put in charge of designing the famous Waterside Station. It brought him in close contact with John W. Lieb and Thomas E. Murray and with design and construction work of all kinds throughout the nation and the world. No job was too big or too novel; and under him grew up generation after generation of engineers who still speak of him as "Uncle George."

Such versatility as was evident in his engineering work was characteristic too of all Orrok's interest. Of all subjects from archaeology to zoology he had more than a smattering of knowledge. An omniverous reader, there was little that escaped his attention. Science, politics, philosophy, fiction, detective stories, verse—all that came to his attention was read, and much of it was remembered. A quotation, a few stray bits of Kipling or Brete Harte, doggerel by forgotten rhymesters interlarded his conversation. The making of chowder, Boston style, was as much of a specialty with him as formulas for furnace radiation. Wines, pears, fish he could identify unerringly. No waiter could palm off on him deep-sea scallops for the Long Island variety. He knew the habitats of oysters and shad as well as he knew the number of Republican and Democratic voters in Scotland, Conn., where he served as first selectman. By tradition a Democrat, he became a Republican because of Woodrow Wilson; the follies of the New Deal moved him to violent and picturesque language. No one ever doubted where he stood on any subject.

A member of many engineering societies, lecturer in several universities, writer of papers and books on engineering subjects, Orrok served the A.S.M.E. in capacities too numerous to mention. For years chairman of the Committee on Publications, he never missed a reunion dinner. He was one of the founders of the Society's first professional division, known in those days as the Gas Power Section. His efforts to revise the steam tables resulted in one of the most outstanding pieces of research ever conducted under the auspices of the Society. Frequent trips to Europe made him well known and highly respected there.

Never a robust man, Orrok spent most of his evenings at home. When the dinner table was cleared he would get out his flute and play lilting tunes and dance music to the tapping of his high-arched foot. In latter years he traveled only to take a vacation or when his services were needed in some such place as Panama or the New York City watershed. His office and the luncheon table at the Engineers' Club were the meeting places where friends and engineers from the entire world came to see him. Active to the last, his opening question was, "What's new?" His influence still continues, and hundreds of bits of whimsical memories will keep him alive to the friends who loved and respected him.

One of his feats was to recite a story of a whaling expedition to the delight of his companions. Scraps of it come to mind; and none serves as an epitaph, for a man who never allowed the years to engulf or impede him, better than the closing line, "I goes for'ard!"

Publicity

ALTHOUGH a surprising number of persons will say that they do not want publicity, it is only human nature for a man to get some sort of a thrill at seeing his name in the papers. Organizations are more objective. They pay money to advertise and they pay out more good money to get their activities before the public in newspapers and magazines and over the radio. The American Society of Mechanical Engineers is no exception. It advertises, mostly in trade magazines read by the advertising fraternity, and it contracts with a public-relations director, George Aubrey Hastings, of New York, to see that the press of the nation, the science, technical, and editorial writers, the commentators, and the engineering magazines are informed about A.S.M.E. activities.

The director of public relations conducts most of his activities just before and during Society meetings. He maintains a pressroom at the convention headquarters where copies of papers are available for reporters. He prepares "releases" or "handouts" which summarize the high lights of the program, the addresses delivered at luncheons and dinners, and the technical papers presented at the sessions. These stories are prepared in advance and are mailed to the various press services and newspapers.

Publicity is not an easy job; but it would be much easier if everyone would help the man who is trying to pull it off. At the 1943 A.S.M.E. Annual Meeting there were 219 addresses and papers to be publicized in addition to the general day-by-day news of the meeting. Only 128 of these papers and addresses were received in advance of the meeting. Many of the papers not received in advance were the very best from the point of view of public interest. More than one quarter of the papers received in advance were so technical that only a man working in the field of the author's interest with an extraordinary flair for newspaper work could write a story based on them that would get by a city editor. Who loses in these cases? Everyone—the author and his employer who miss an opportunity to let the people know what they are doing; the Society whose work is not adequately brought to the attention of the public; and the nation itself which remains ignorant of what mechanical engineers are doing and thinking about.

Every author can help by providing a copy of his paper in advance and by writing a readable abstract in which the essential points are clearly set forth.

HIGH-SPEED MILLING *With* NEGATIVE RAKE ANGLES

By HANS ERNST

RESEARCH DIRECTOR, THE CINCINNATI MILLING MACHINE COMPANY. MEMBER A.S.M.E.

THE past three years have witnessed the gradual growth of a new procedure in the milling of steel, viz., the utilization of sintered-carbide cutters, with negative rake angles, operated at cutting speeds appreciably higher than formerly thought practicable even with these exceedingly hard cutting materials. This procedure has approached maturity in recent months through developments in the large aircraft plants of the Pacific Coast, notably Boeing, Vega, and Douglas, where it is now an established manufacturing practice. Important contributions to this development have also been made by the manufacturers of carbides and carbide-tipped cutters, and by the builders of machine tools Applications are being made daily in many plants throughout the country on a wide variety of work.

Recent Pacific Coast practice is characterized by a relatively large feed per tooth and a somewhat lower cutting speed than that used during the experimental period. Down-milling is generally employed, and a flywheel is used wherever possible. In many applications the feed rate is limited only by the power available in the machine.

The advantages obtained with this new procedure are higher production, improved finish, and less distortion of work due to heat; with high-speed operation most of the heat is carried off with the chips. In many cases production has been increased several hundred per cent over that previously obtained with high-speed-steel cutters and, with the higher feed per tooth now employed, the power per unit volume of metal removed is not excessive.

ASTONISHING RESULTS

At first sight these results appear astonishing and directly opposed to what we have known of metal-cutting theory. The stronger tooth form obtained with the negative rake angle is obviously an advantage, but this would seem to be more than offset by a less effective cutting action, as former investigations have shown clearly that the power required to remove metal increases greatly as the conventional positive rake angle is decreased. This is indicated in Fig. 1, which shows the relationship between cutting force and positive rake angle for one particular set of conditions, and which is typical of the relationship found in practice with the cutting speeds usually employed with high-speed steel cutters.

From this diagram it would seem obvious that, if the rake angle were made negative, there would be a still further increase in cutting force and, consequently, in the power required to remove a unit volume of metal. Recent metal-cutting research indicates, however, that while the specific power for tools with negative rake angles is high when the cutting speed is low, this is not true when the cutting speed is high. Careful investigations over a very wide range of speeds, and with various work materials, have shown that the power required with negative rake angles decreases steadily with increase in speed. In fact, in several cases it has been found that, beyond a certain speed, the specific power consumption with negative rake angles may approach that with positive rake angles. If this characteristic should prove to be universally true, then it follows that, as permissible cutting speeds reach still higher values through the development of still better cutting-tool materials, the negative rake angle will have an increasing advantage over the positive rake angle, not only because of the greater inherent strength provided thereby, but also because of the lower power consumption.

Fig. 2 illustrates the first observation of this relationship of which we have record. This was made in May, 1942, by Dr. M. E. Merchant and Mr. N. Zlatin from data obtained with a special machinability dynamometer constructed in the research laboratory of the author's company. From this chart it will be noted that there was a marked decrease in the cutting force with increase in speed in the case of the tool with 10-deg negative rake angle, whereas a rise in the cutting force with increase in speed was observed for the tool with a 10-deg positive rake angle. Thus the two cutting-force curves approach each other as the cutting speed is increased. In this particular case, at a speed of 730 fpm, the cutting forces were about equal for both the positive and negative rake angles.

Similar relationships have since been observed in investigations with other materials, as illustrated in Fig. 3 (*a*, *b*, and *c*). In every case there has been found a marked decrease of cutting force with speed for the negative rake angle, and an

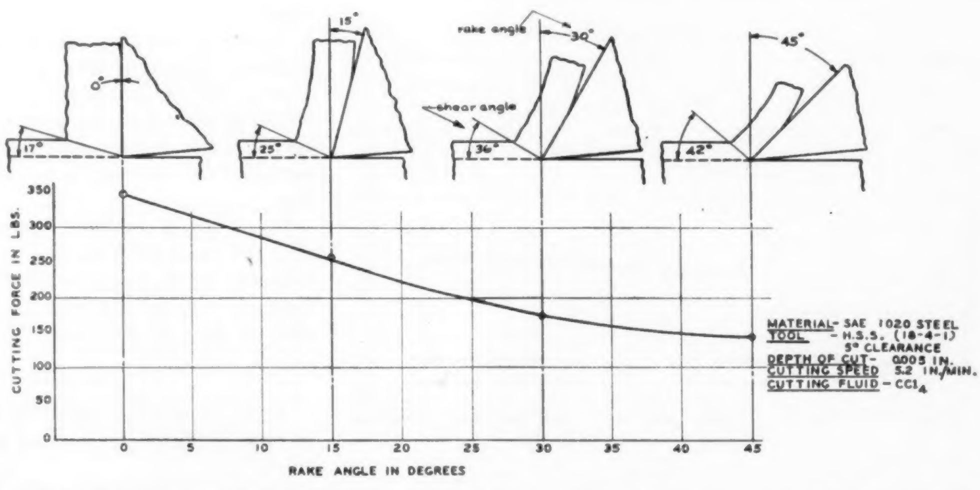

FIG. 1 RELATIONSHIP BETWEEN CUTTING FORCE AND POSITIVE RAKE ANGLE, TYPICAL FOR CUTTING SPEEDS EMPLOYED WITH HIGH-SPEED STEEL CUTTERS

Contributed by the Production Engineering Division and presented as part of a Symposium on High-Speed Milling at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

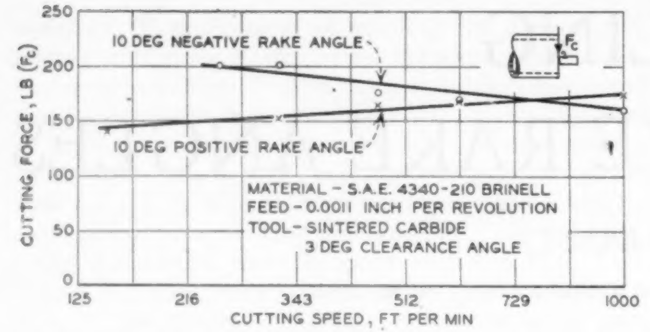

FIG. 2 CURVES OF CUTTING FORCE VERSUS CUTTING SPEED FROM DATA TAKEN IN 1942 BY MERCHANT AND ZLATIN

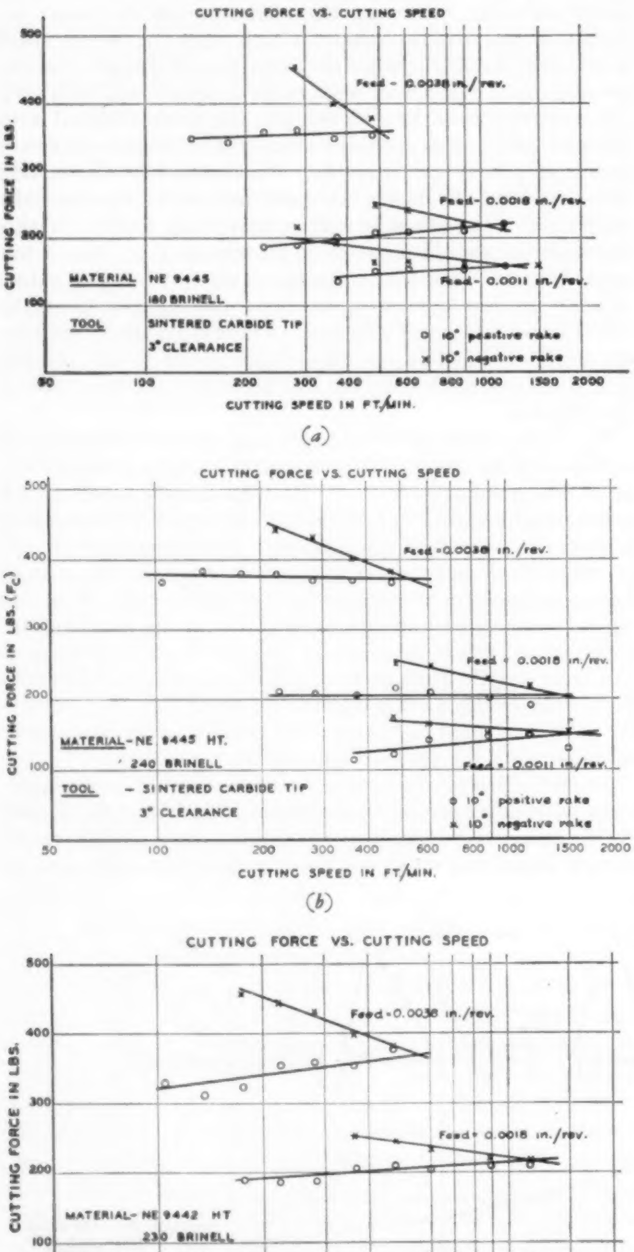

FIG. 3 ADDITIONAL CURVES SHOWING DECREASE OF CUTTING FORCE WITH SPEED FOR NEGATIVE RAKE ANGLE

approach of the curves with increasing cutting speed. It will also be noted from these charts that the point of close approach of the force curves was not constant but varied with the cutting conditions, being lower when the feed per revolution was larger.

While the foregoing tests were made with a single-point tool, cutting on the end of a tube, a similar relationship also has been found with high-speed milling cutters on both steel and aluminum.

WHAT IS THE ANSWER?

Relationships such as presented in these charts raise the inevitable question: "Why?" While we do not have the complete answer, it is now clear that the key lies in the large reduction both in the coefficient of friction, and the force of friction between the sliding chip and the tool face, obtained with this combination of high-speed and negative rake.

For a proper understanding of these effects and their possible causes we must construct force diagrams,[1] showing the geometrical relationships existing at the cutting edge. Fig. 4 shows this relationship for a sintered-carbide tool with 10-deg positive true rake, machining S.A.E. 4340 steel of 210 Bhn at a cutting speed of 610 fpm. In this case the observed cutting force F_c was 165 lb, and the observed coefficient of friction $\frac{F}{N}$ (or $\tan \tau$) was 1.24. The observed shear angle, ϕ obs., was 23 deg while the theoretical shear angle, ϕ theor. (calculated from equation $\phi = 45 + \frac{\alpha}{2} - \frac{\tau}{2}$) was 24.4 deg. In constructing such diagrams, the resultant force R acting between tool and work is taken as the diameter of a force circle which, therefore, contains all the mutually perpendicular pairs of components acting on tool and work.

It is interesting to note that in this case the theoretical and observed values of the shear angle differ by only a small amount, the slight lowering of the observed shear angle being due to the fact that the material does not shear in exactly the direction of the maximum shearing stress.

Fig 5 has been constructed to show the changes in the force system which would result when changing from a 10-deg positive- to a 10-deg-negative-rake tool *if* the coefficient of friction remained the same. From the equation just given, it will be seen that the theoretical shear angle would be reduced from 24.4 deg to 14.4 deg, and from the geometry of the diagram we may find by calculation that the value of the cutting force F_c would be 259 lb. This would indicate an increase in power of approximately 56 per cent for the same metal removal. The resultant force between tool and work would be approximately two and one-half times that for the 10-deg positive rake angle.

Actually, however, the force relationships with the 10-deg negative rake angle are not as indicated in Fig. 5, as the coefficient of friction *does not* remain the same. In a careful test with all other conditions the same as in Fig. 4, it was found that the coefficient of friction had decreased from 1.24 to 0.66, while the observed shear angle had decreased only from 23 deg to 17 deg.

Fig. 6 shows the force system for this case. It will be noted that the resultant force R is actually less than one half of that indicated by the hypothetical diagram Fig. 5, while the cutting force F_c is actually 176 lb, an increase of only 6 per cent over that for the tool with the 10-deg positive rake.

DECREASE OF FRICTION

While these force diagrams clearly show how the decrease in both coefficient of friction and force of friction (which has

[1] See Fig. 8, "Chip Formation, Friction, and Finish," by H. Ernst and M. E. Merchant; a booklet published by the Cincinnati Milling Machine Company, Cincinnati, Ohio.

been observed with negative-rake tools at high cutting speeds) brings about a reduction in cutting force, there still remains the question: "Why does the friction decrease?" As indicated in the foregoing, this question cannot be fully answered until additional theoretical metal-cutting research and tests have been carried out. At present, however, there is good reason to believe that this is at least partly the result of a decrease in shear strength due to increase in temperature in a thin layer of chip metal adjacent to the tool face. Quoting from a report by Dr. Merchant covering an investigation made with the Cincinnati "machinability dynamometer:"

"Our studies have shown that the frictional resistance which the chip encounters in sliding on the tool face is due to actual adhesion between the chip and tool, making it necessary actually to shear a thin layer of the chip metal in order to produce relative motion. Thus anything which reduces the shear strength of the chip metal in the thin layer adjacent to the tool face should reduce the frictional force. It is well known that the shear strength of a metal decreases as its temperature is raised, and it is evident that when the temperature reaches the melting point of the metal, the shear strength would become zero. Since the work which is being done by the frictional force acting at the chip-tool interface increases with increasing speed, the temperature at that interface should also increase, and thus the frictional force should decrease with increasing speed.

"Although such a picture is somewhat oversimplified, and does not take account of other variables which affect the shear strength and the friction, it does indicate that with sufficiently high speeds and with tool materials having sufficiently low heat conductivity, it should be possible to reach the melting temperature of the chip metal at the chip-tool interface, and thus to reduce the friction force to practically zero. Only the frictional resistance due to the viscosity of the molten metal would remain. It appears likely that such an ideal condition as described could be attained at lower cutting speeds with negative-rake-angle tools than with positive rakes."

CHIP-FLOW PHENOMENA OBSERVED

Since the foregoing report was written, additional tests have been made with both positive and negative rake angles over a wide range of speeds, and photomicrographs have been prepared of chip cross sections made under these conditions. In order to obtain a true picture of the chip-flow phenomena at the actual speed of operation, a special mechanism was devised which permitted stopping the motion of the chip relative to the tool in an incredibly short space of time, actually only about 0.000002 sec at the highest cutting speed used in these tests.

Fig. 7(*a*) is a photomicrograph of the cross section of a partially formed chip made with a single-toothed carbide-tipped face-milling cutter having a 10-deg positive true rake and 3-deg clearance, and operating with a cutting speed of 140 fpm. The material of the workpiece was S.A.E. 1112 steel and the feed increment (f) normal to the surface generated by the cutting edge was 0.004 in. No cutting fluid was used.

Under these conditions, a moderately large built-up edge was formed, the shear angle was approximately 16 deg, and the cutting ratio $\left(\frac{f}{t}\right)$ was about 0.28.

In forming the chip shown in Fig. 7(*b*), all conditions were identical with those of Fig. 7(*a*) except that the true rake angle of the milling-cutter tooth had been changed from +10 deg to —10 deg. With this negative rake angle, and the relatively low cutting speed of 140 fpm, the cutting action was very bad. The force of friction between the chip and the face of the cutting tooth was so high in this case that the metal piled up in front of the tooth until a rupture developed. The shear angle in this instance was only about 6 deg and the cutting ratio only 0.11.

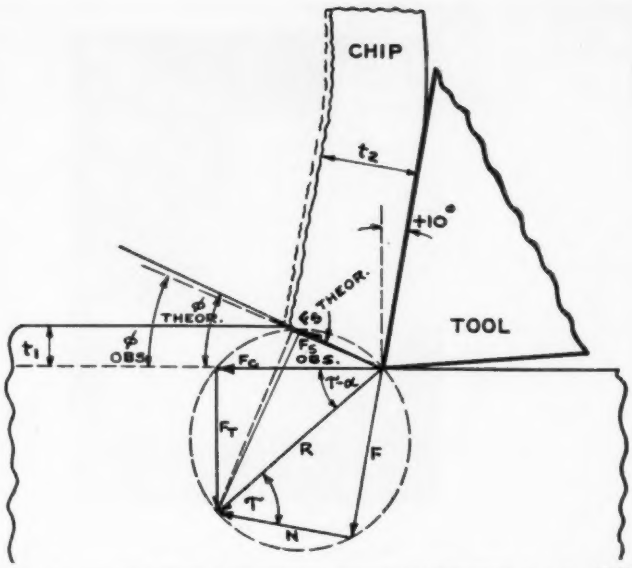

FIG. 4 FORCE SYSTEM OBSERVED WHEN MACHINING S.A.E. 4340 STEEL OF 210 BHN AT 610 FPM, WITH TOOL HAVING 10 DEG POSITIVE RAKE. OBSERVED COEFFICIENT OF FRICTION = 1.24

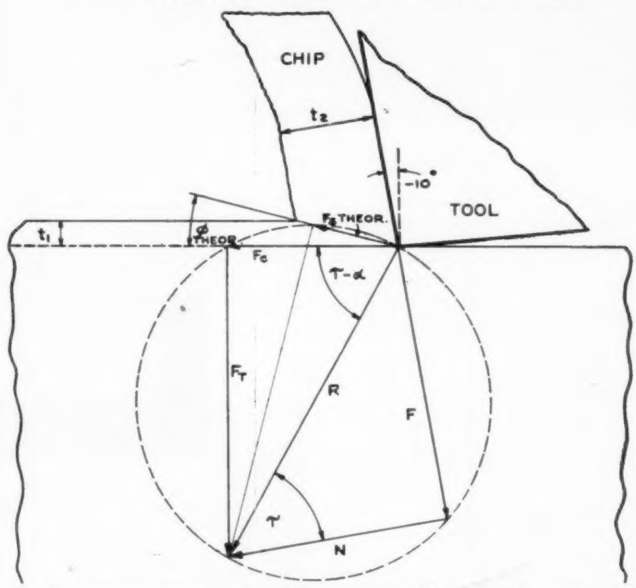

FIG. 5 HYPOTHETICAL FORCE DIAGRAM FOR 10 DEG NEGATIVE RAKE ASSUMING COEFFICIENT OF FRICTION AND ALL OTHER CONDITIONS TO BE SAME AS IN FIG. 4

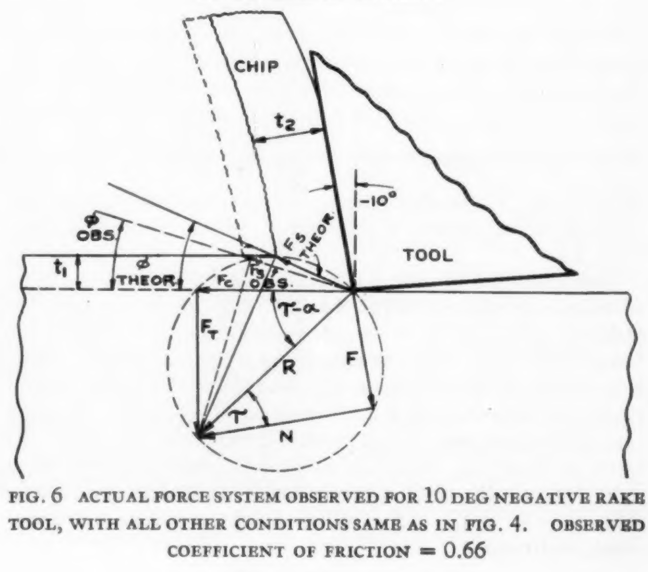

FIG. 6 ACTUAL FORCE SYSTEM OBSERVED FOR 10 DEG NEGATIVE RAKE TOOL, WITH ALL OTHER CONDITIONS SAME AS IN FIG. 4. OBSERVED COEFFICIENT OF FRICTION = 0.66

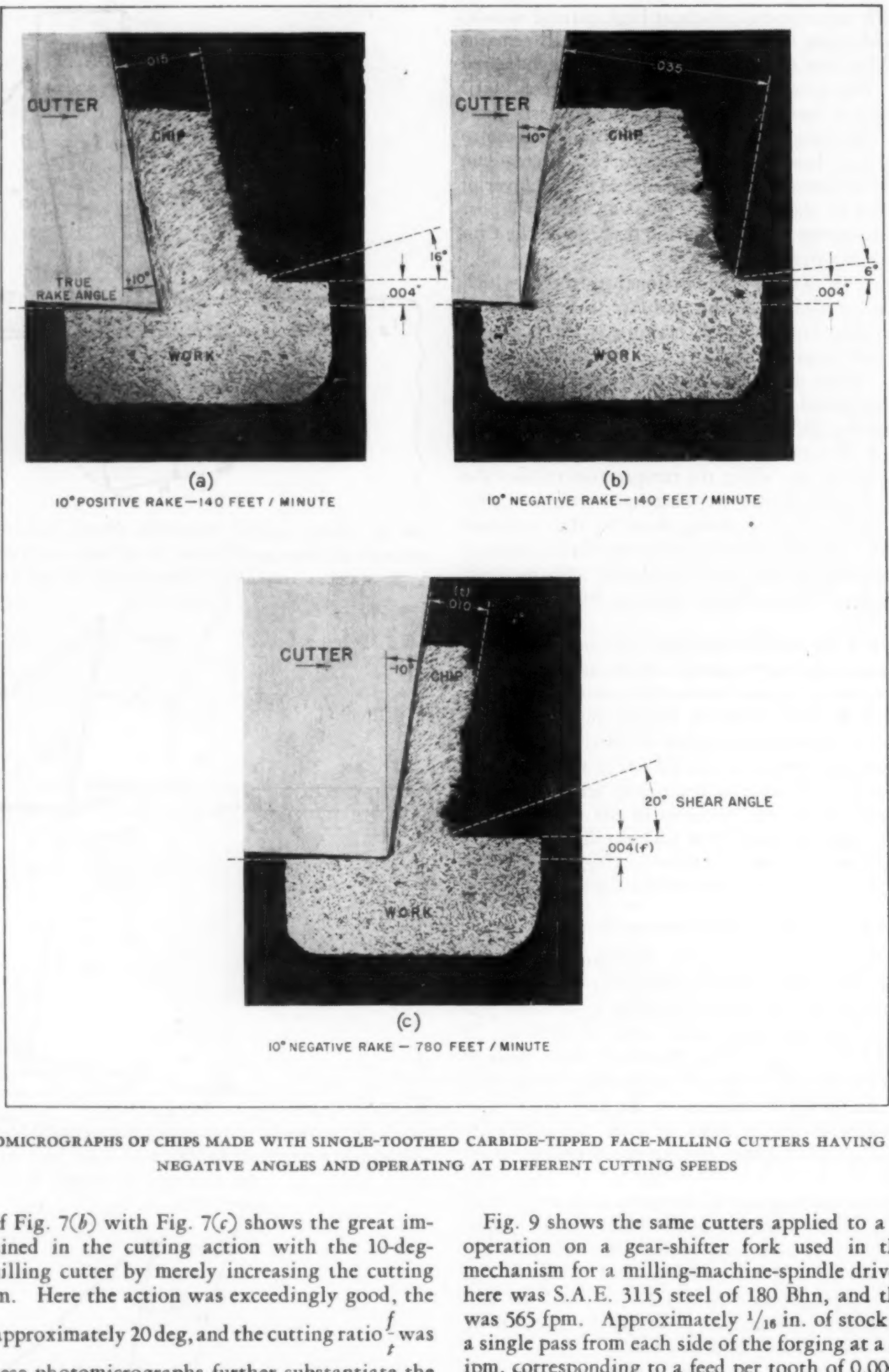

FIG. 7 PHOTOMICROGRAPHS OF CHIPS MADE WITH SINGLE-TOOTHED CARBIDE-TIPPED FACE-MILLING CUTTERS HAVING POSITIVE AND NEGATIVE ANGLES AND OPERATING AT DIFFERENT CUTTING SPEEDS

Comparison of Fig. 7(*b*) with Fig. 7(*c*) shows the great improvement obtained in the cutting action with the 10-deg-negative-rake milling cutter by merely increasing the cutting speed to 780 fpm. Here the action was exceedingly good, the shear angle was approximately 20 deg, and the cutting ratio $\frac{f}{t}$ was about 0.40. These photomicrographs further substantiate the "cutting force versus cutting speed" relationships shown in Figs. 2 and 3.

Two examples of practical applications of this new milling technique are shown in Figs. 8 and 9. Fig. 8 shows a straddle-milling operation on a forged aircraft-landing-gear strut of S.A.E. 4140 steel with 330 Bhn, using a pair of half-side mills, 8 in. diam, with 10 carbide tips brazed to a solid Meehanite body, and operating at a cutting speed of 440 fpm. The feed rate in this case was 15 ipm, which corresponds to a feed per tooth of 0.007 in. Both the axial rake and radial rake were —10 deg, which, with a corner angle of 45 deg, gave a true rake of —14 deg. An excellent finish was obtained under these conditions.

Fig. 9 shows the same cutters applied to a straddle-milling operation on a gear-shifter fork used in the speed-change mechanism for a milling-machine-spindle drive. The material here was S.A.E. 3115 steel of 180 Bhn, and the cutting speed was 565 fpm. Approximately $\frac{1}{16}$ in. of stock was removed in a single pass from each side of the forging at a feed rate of $15\frac{3}{8}$ ipm, corresponding to a feed per tooth of 0.006 in. When this operation was performed previously with a high-speed-steel cutter, it was necessary to take both a roughing and finishing cut, at a feed rate of approximately 3 ipm, in order to obtain a satisfactory finish.

CONCLUSION

By the development of this new procedure, the 15-year dream of milling steel with carbide-tipped cutters has now become a reality. The use of negative true rake angles and high speeds is not a fad of the moment but represents a real advance in milling procedure; as stronger carbides are developed, still higher cutting speeds may be used, with perhaps even higher feed per tooth than is possible with present carbides, thus permitting

the still more efficient metal removal indicated by the relationships shown in Fig. 3.

However, here as elsewhere, we do not get something for nothing. In order to obtain the maximum benefit in increased production, coupled with good finish and long cutter life, it is essential that great care be exercised in the preparation and maintenance of cutters. In our opinion, many of the cases of variation in performance, or poor performance, experienced when attempting to use the new procedure, may be traced to improper practice in cutter grinding.

Extreme care must be taken to avoid local overheating of the cutting edge; the grinding wheel must be rotated against the tooth being ground, so that the grinding grits approach the cutting edge from the face of the tooth and not the flank; only very small amounts of carbide must be removed per pass, preferably not over 0.0003 in. per pass for roughing, and 0.0001 to 0.00015 in. per pass for finishing. Both for rough-grinding and finish-grinding, we prefer to use diamond-impregnated wheels; a 100-grit diamond wheel for roughing, and a 400-grit wheel for finishing. A pad soaked with kerosene or very light oil should bear against the wheel while grinding. Sufficient carbide must be removed to eliminate completely the portion damaged by the previous run; for this reason, carbide-tipped cutters should be changed when only slightly worn. After grinding, the cutting edges should always be inspected with a low-power microscope.

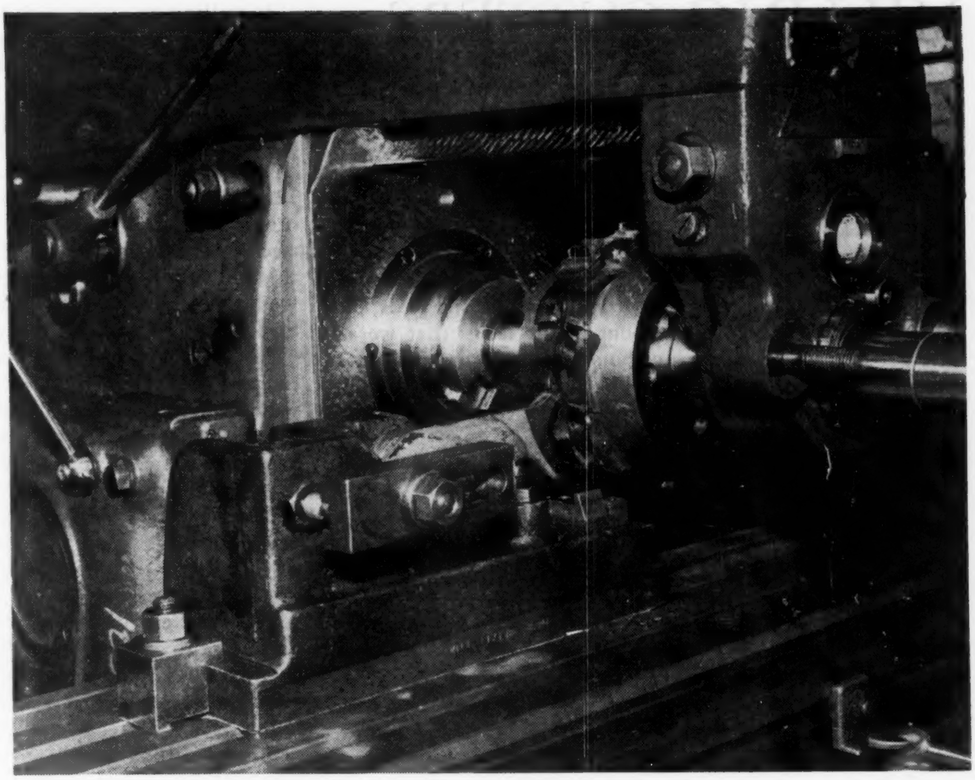

FIG. 9 STRADDLE-MILLING OPERATION ON GEAR-SHIFTER FORK

With rigid work mountings, flywheels where necessary to maintain more uniform cutting speeds, and properly designed and carefully ground cutters, excellent results can and are being obtained with the new procedure on existing standard milling machines. However, as may be shown by a simple calculation, the high cutting speeds now used permit, in certain cases, the use of considerably higher powers than have generally been provided on standard machines, without overloading the cutting teeth.

The machine-tool manufacturers are fully aware of these possibilities, and thus we may confidently expect even higher levels of productivity from machine tools which have been specially designed for the use of carbides, in the not too distant future.

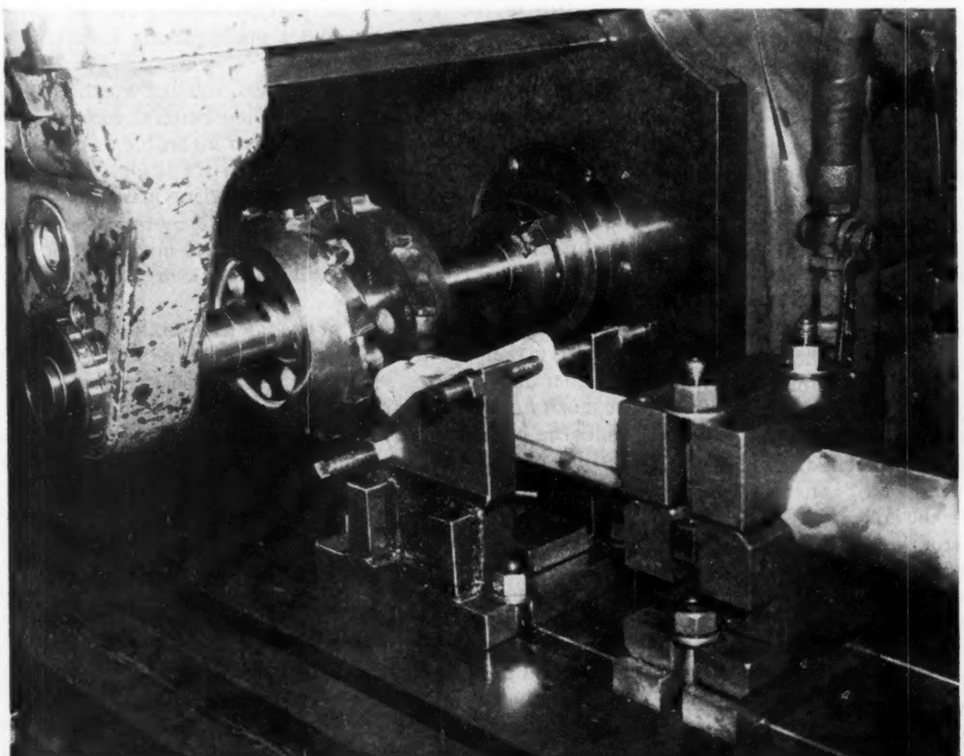

FIG. 8 STRADDLE-MILLING OPERATION ON FORGED AIRCRAFT-LANDING-GEAR STRUT

MILLING CUTTERS *as* CUTTING TOOLS

By ARTHUR A. SCHWARTZ

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MUCH has been published about milling cutters, their size, shape, contour, blading angles, speeds, and feeds, but little has been done about it. It seems that we all have got into a rut of thinking about a milling cutter as something entirely apart from other cutting tools. Milling cutters are created by the manufacturers and come to us as manufactured, so we cannot question their perfection.

On pages 21–40 of Kent's "Mechanical Engineers' Handbook" (11th edition) is a table of permissible feeds *per tooth* of milling cutters; yet we seldom see the number of teeth mentioned when a feed is stated for a milling cutter. A recently purchased inserted tooth shell end mill of approximately 15 in. diameter proved to have 60 teeth. Going back to Kent's handbook, we find a recommended feed of 0.016 in. per tooth for 1020 S.A.E. steel which works out to $0.016 \times 60 = 0.960$ in. feed per cutter revolution. Again, according to the handbook, the recommended speed for 1020 S.A.E. is 85 fpm or for the 15-in. cutter, 21–22 rpm, a feed of 20 in. per min. According to the handbook formula, $Hp = KFWD$, and assuming average removal of $^1/_4$ in. from a piece 10 in. wide, at a low estimate 110 hp will be needed in addition to horsepower required for the operation of machine. This would mean a peripheral force of 42,700 lb.

Of course this is absurd, but it is no more absurd than to make a cutter having 60 teeth. In this type of cutter two peripheral screws hold each blade. Probably the only limit to the number of teeth was the available space for the screws. The purchasing department probably felt that the more teeth the longer the cutter would last and so the somewhat high price was justified.

So much for theory. What happens in the shop? The cutter's first job is surfacing a few bosses on a rather fragile forging. The cutter is run at about 50 rpm, the depth of cut varies $^1/_{16}$ to $^5/_{16}$ in., the feed is a steady 2 in. per min. On the second job the cutter is performing at about 100 rpm, taking a rough cut 0 to $^3/_8$ in. deep from a casting about 6 in. wide at a good feed of $5^3/_4$ in. per min. The casting is of aluminum.

In both operations the feed per tooth is well under 0.001 in. and the result is that many more teeth slip over the work than bite into it. This means much heat generated, blades dulled, and useless power consumed.

In all machining operations the generated heat is the limiting factor on the speed of operation. To increase the speed of production we must first decrease as much as possible the generation of heat in the part and in the tool, and second, increase the dissipation of heat so generated as much as possible.

Observation of any machining operation will disclose the fact that a great percentage of the generated heat is in the chips. A long curling chip being cut on a lathe comes off the tool with the side next to the tool still a natural color, but on the opposite side the chip turns yellow, brown, purple, or blue, depending on the cut being taken. This proves that most of the heat is concentrated, or perhaps generated, on the inner surface of the chip, the side that is being compressed. Therefore, the quicker we can get rid of these shavings the faster we can remove them from the vicinity of the tool or the part being machined, the less heat will enter the tool or the part.

Contributed by the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers.

In milling we accomplish this by increasing the speed of the revolving cutter. This statement will be challenged by many good mechanics as we are in the habit of thinking that the heat generated is in proportion to the speed. This is true only if all other conditions remain proportional to the speed. Thus in milling, if we increase the speed we also increase the number of chips cut per unit of time, and it is self-evident that to cut 12 chips instead of four generates more heat. But if we changed other conditions also, if we used a four-bladed instead of a twelve-bladed cutter and made the same number of chips, then this old rule would no longer hold. The actual cutting time would now be reduced to one third of the regular time as the blades would move three times as fast.

Also, the inactive time, the time during which the tool and the part is cooling, would be three times as long and the result would be an over-all reduction of heat in the cutter and in the part, the generated heat would be concentrated more in the chips where it can be readily dissipated and where it does no harm. With four blades we can also increase the thickness of the individual chips by increasing the feed per unit of time at least 50 per cent and in some cases, like the cutter mentioned in the first part of this paper, we may increase the feed two or three hundred per cent.

Too much emphasis cannot be put on the thickness of the individual chips. Theoretically, we can cut a chip, say, 0.0002 in. thick, but that would require a cutter or blade with an edge about as sharp as a good razor blade, where in reality the edge of a good sharp cutter has a radius of about 0.0005 in. In conventional milling each blade slides over the part until the pressure sinks it deep enough into the material to start a chip. Many times one or more blades of a multiblade cutter fail to "take a bite" because the pressure is too slight. Much heat is generated in the part and in the sliding blade where it does the most damage to the cutting edge and to the part that is to be machined by the succeeding blade.

Measurements have not been made, but it is believed that this uselessly imparted heat of one sliding noncutting blade is greater than the heat imparted by one blade cutting a normal chip. It is also believed that the difference between the heat imparted to the tool and the part by a blade cutting a thin shaving of about 0.002 in. and a blade cutting a shaving of about 0.010 is slight.

Summarizing, simple milling cutters, some of which are now on the market, are recommended. These cutters can be bought or made to order with cutter bodies of malleable or cast iron, meehanite, or mild steel, with one to six blades, preferably brazed. There is also a choice of the cutting material. High-speed steel can be built up on the soft bodies by the use of one of the many welding rods of high-speed steel now sold for that purpose. This conserves the scarce metal as it is used only for the actual cutting blades.

We may also use any one of the nonferrous alloys offered by various makers. These alloys can be brazed to the cutter bodies without danger of drawing their temper and they can be used at much higher speeds than high-speed steel. Any of the carbides can be brazed on, although they are not recommended for milling cutters to be used on steel, or at speeds over 600 fpm or where the available power is a factor. Carbides are definitely brittle, and the interrupted cutting of a milling cutter on steel is likely to shatter them. At really high speeds vibration is hard on carbides and as they must have very little, if any, rake, they consume more power than other cutting materials per pound of shavings made. One more reason, besides quick availability and ease of machining, for the use of malleable iron in these cutter bodies is their actual resistance to vibration. This material is almost as inert to vibration as lead is.

In milling we have succeeding impacts which tend to set up vibrations in the blades and at high speeds these vibrations can become destructive. That is why the writer prefers malleable iron for cutter bodies.

Determining TOOL EFFICIENCY *in* HIGH-SPEED MILLING

By WALLACE E. BRAINARD

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THE immediate objective of research on the machining of aluminum alloys, being conducted by the author's company, is to develop a simple and accurate method of comparing and evaluating various designs of high-speed milling cutters. The simplest way of accomplishing this purpose is one of measuring loads directly at the cutter and equating these in terms of material removed. The cutter holder is treated as a beam, and a strain gage is used to measure applied loads.

ELECTRICAL-TYPE STRAIN GAGE USED TO MEASURE CUTTER LOAD

The modern electrical-type strain gage, Fig. 1, was chosen as it is simple, sensitive, and accurate. It consists of a small-diameter resistance wire secured to a paper base. The gage is cemented to the cutter holder. As the holder bends, the wire is stretched, its diameter is reduced, and the resistance increases in direct ratio to the applied load, Fig. 2. As all strains on the resistance wire are well within its elastic limit, variable loads may be measured.

Fig. 3 shows the method applied to a lathe, used for preliminary investigation in order to take advantage of continuous cutting, and simple setup. The strain gage is mounted on a tool holder at a position of greatest deflection. The setup was calibrated in pounds loading, tangent to the work, by suspending known weights from a wire extending downward over the tool cutting edge. The blocks represent a conventional resistance bridge and galvanometer, used to measure the resistance change.

By means of this method, the relationships between cutter load, in pounds, and work surface velocity, were measured. It was determined there was no change in load as surface velocity changes, for speed variations within the test range of 200 and 1500 fpm. This experiment was repeated for various feed-and-depth combinations, from light to heavy, Fig. 4.

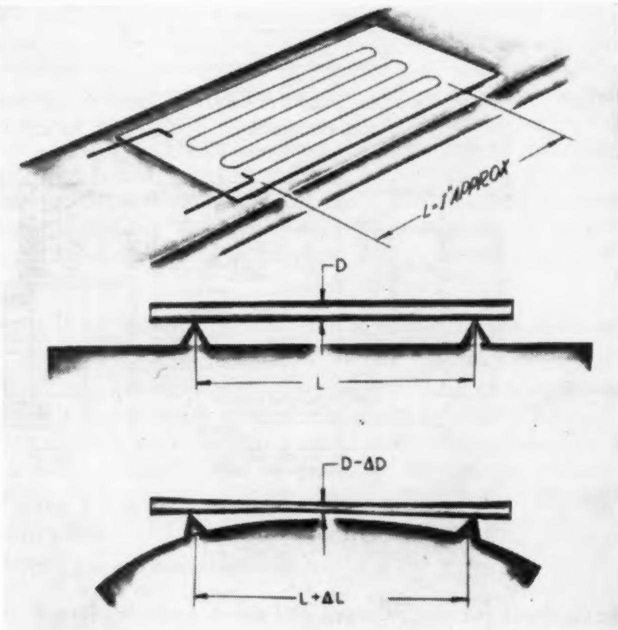
Fig. 5 shows the manner in which cutter load was found to vary as the feed was changed. Curves for six different depths are shown. It will be noted the curves are losing their slope as feed is increased, indicating increased efficiency with greater cut depth.

The same data were replotted, Fig. 6, to show the variations in load as the depth of cut was chosen. It will be noted the curves more closely approach linear relationship.

It appeared advisable to adopt some method of evaluating cutter performance in terms of work, and quantity of metal removed. Due to the elimination of the question, "does surface velocity affect cutter load," a simple answer to this problem became evident. By omitting the time factor, such items as horsepower and revolutions per minute were eliminated, and hence the ratio of load to chip area could be compared with any independent variable selected.

MEASURING TEAR OF THE CHIP

To express the idea simply, we measure shear or tear of the chip in terms of pounds per square inch. Fig. 7 shows a typical application. The chip shear, in pounds per square inch, is plotted vertically. The curves show how the shear changes as



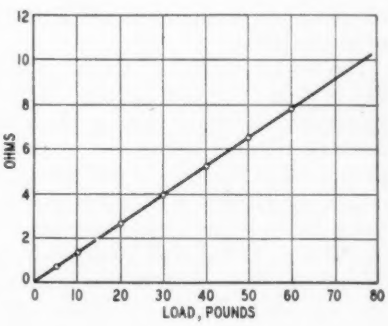
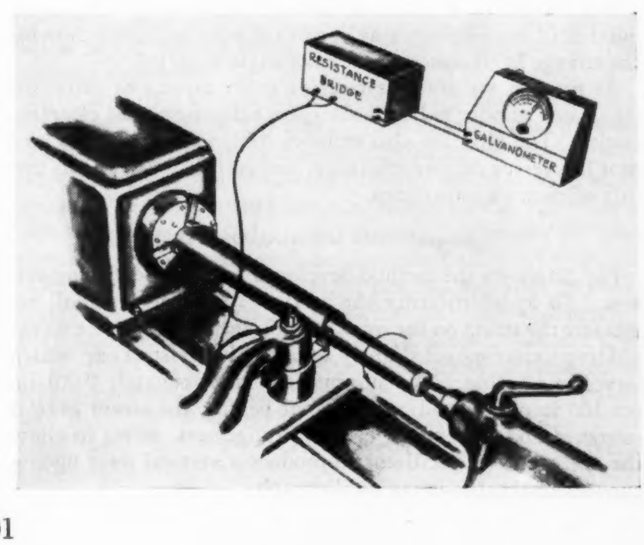


FIG. 1 (ABOVE) ELECTRICAL STRAIN GAGE

FIG. 2 (RIGHT) CALIBRATION CURVE FOR LATHE - TOOL - HOLDER STRAIN GAGE

FIG. 3 (BELOW) APPLYING METHOD TO LATHE



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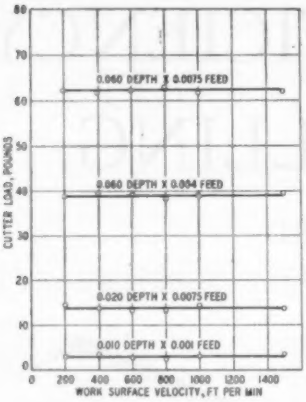


FIG. 4 VELOCITY-LOAD RELATIONSHIP

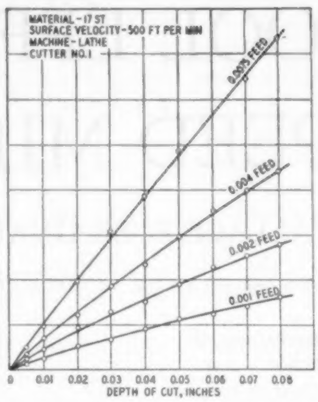


FIG. 5 CUTTER LOAD AS DEPTH OF CUT IS VARIED

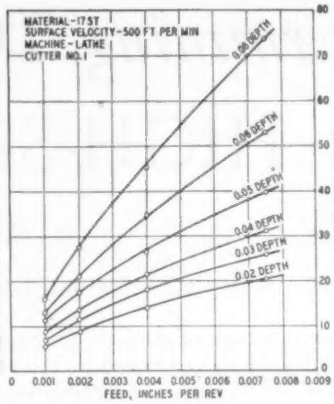


FIG. 6 CUTTER LOAD AS FEED IS VARIED

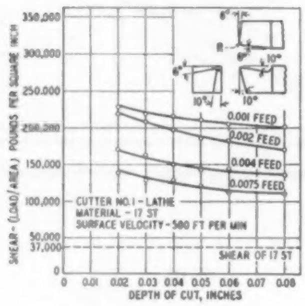


FIG. 7 CUTTING SHEAR - CUT DEPTH RELATIONSHIP

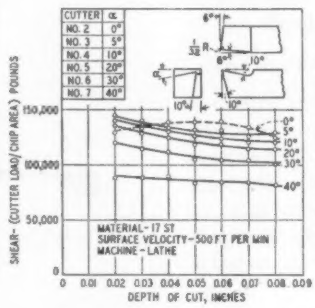


FIG. 8 EFFECT ON CUTTER SHEAR WHEN SIDE-CUTTING RAKE ANGLE IS VARIED

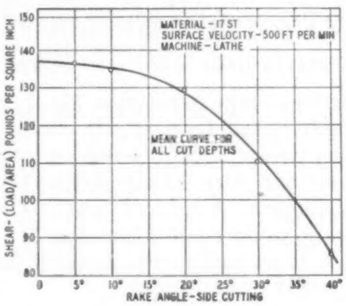


FIG. 9 CHANGE OF CUTTER LOAD AS SIDE-CUTTING RAKE ANGLE IS VARIED

the cut depth is varied. Curves for different feeds are plotted. By this method the efficiency of cutters can be easily compared. The largest chip required a shearing load of 112,000 psi, an interesting comparison with the 37,000 psi actual shear strength of the material.

Having established a method of comparing tool efficiencies, Fig. 8 shows the idea applied. This series of curves is for a group of tools having various side-cutting rake angles, all other dimensions being identical. As the cut depth is chosen, the shear load is shown. It will be noted the cutter with 0-deg rake angle showed a comparatively erratic performance. The 5-deg cutter showed maximum efficiency at a medium depth; the 10-deg, 20-deg, and 30-deg rake-angle cutters showed increased efficiency as depth was increased, leveling out with the heavier cuts. The 40-deg rake-angle cutter showed very consistent performance for all depths of cut.

The curve, Fig. 9, is a computed average derived from a large number of measurements at various depths and feed, showing the change in efficiency as the rake angle is varied.

At present, we are investigating other aspects of cutter design, such as nose radius, back rake, side angle, and clearance angles. The program also includes coolant investigation, and tool life versus cutting efficiency, and surface finish versus cutting efficiency comparisons.

EVALUATING MILLING CUTTERS

Fig. 10 shows the method developed to evaluate milling cutters. To avoid rotating the strain gage with the tool, we measure the strain on the work. Upon cutter impact, the work-holding fixture moves slightly against a heavy steel bar, which serves as a spring. The movement is approximately 0.001 in. per 100 lb cutter load. As the cut begins, the strain gage is stretched and, through a bridge arrangement, serves to allow the voltage of an oscillator to produce a vertical trace upon a conventional cathode-ray oscillograph.

Thus we have an automatic graph, recording the instantaneous load on the cutter, in respect to time, as the pattern is composed of 1000-cycle traces, spaced at 1/1000 sec. The envelope of the image is read in the same manner in which we read the curves shown previously.

The setup is calibrated by applying known loads on the work-holding fixture. The calibration can be instantly checked at any time during an experiment, by means of a simple standard load-substitution device. Photographs of the pattern are taken for study and analysis.

Our experimental program has not developed sufficiently to allow the presentation of quantitative data at present. However, it is felt that some benefit may be derived by those who are engaged in similar research by having described these approaches to the solution of a common problem.

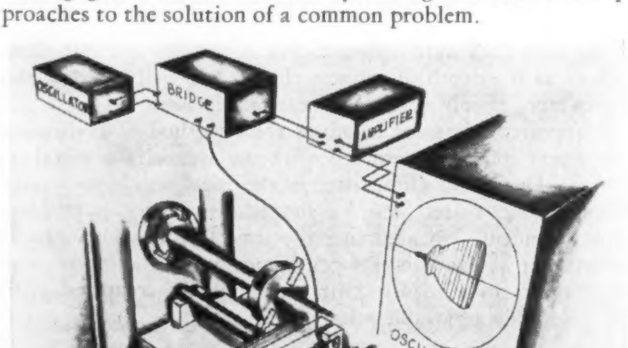


FIG. 10 METHOD OF EVALUATING MILLING CUTTERS

Two Examples of

HIGH-SPEED MILLING

By F. W. LUCHT

DEVELOPMENT ENGINEER, CARBOLOY COMPANY, INC., DETROIT, MICH. MEMBER A.S.M.E.

THE importance of using increased feeds per tooth and optimum cutting speeds when milling steel is well illustrated in two actual milling operations.

At one of the large aircraft-engine plants, master connecting-rod steel forgings were being milled by 6-in-diam inserted-blade face mills having 14 cemented-carbide-tipped blades. These cutters happened to be a standard type of face mill such as is usually furnished by one of the leading milling-cutter manufacturers.

These cutters were operated at a peripheral speed of about 400 fpm and had a feed of 0.0015 in. per tooth. It was found that after milling about ten rods the cutting edges would be chipped badly, and several of the cemented-carbide tips were broken out to an extent which required complete new blades. This meant, not only that much time had to be spent to remove the damaged blades and to reset all the blades in proper relation to each other, but extra time had to be spent in grinding to put the cutter again in good working order.

It was observed from the condition of the teeth which were not completely damaged that the light feed per tooth had increased the width of the wear land behind the cutting edges very rapidly to a point at which the increased pressure from the prematurely dulled cutting edges caused portions of the cutting edges to chip out.

CUTTING DOWN NUMBER OF TEETH INCREASES OUTPUT

Every other tooth in each of the cutters was removed, which left only 7 teeth. The remaining teeth were resharpened exactly the same as previously. This took less time than before. The cutters were also run at the same speed in feet per minute as before, and the same table travel in inches per minute was used, which gave 0.003 in. feed per tooth instead of 0.0015 in. This increase in feed per tooth enabled the cutters to produce about 30 rods per grind instead of the previous 10 rods. Inspection of the cutters showed normal dulling of the teeth without any chipping of the cutting edges or broken teeth. The teeth required only a slight "touch up" with a diamond-impregnated grinding wheel to put them into first-class condition. A set of three face mills finally kept this operation running. One cutter was on the milling machine, one sharpened cutter was at the milling machine ready to use, and another cutter was in the grinding room being resharpened.

This incident gives an idea of how an increased feed per tooth in a milling cutter increases the output of a milling machine, helps to increase the output of the cutter-grinding department, and also to increase the number of parts which can be obtained from a given set of blades.

In another case 4-in-diam multitooth face-milling cutters, which had 10 to 12 teeth, were being used for milling S.A.E. 1095 pieces. These cutters were cemented-carbide-tipped and were similar to high-speed-steel cutters, except for the fact that they were made with negative axial rake and negative radial rake angles.

These cutters were run at peripheral cutting speeds of 200 to 300 fpm. These same speeds were used for turning similar material. The table travel used was slightly below that which the knee-type milling machines would pull without stalling. It was found that the cutters had to be removed from the milling machines in about 2 hr because the teeth tended to become badly chipped. This meant that the down time of the milling machines became a sizable problem, a large backlog of dull cutters would accumulate around the cutter grinding machine, and the milling machine would frequently either have to wait for sharp cutters or return to the use of the high-speed-steel cutters.

FLY CUTTER ELIMINATES GRINDING BOTTLENECK, AND INCREASES CHIP LOAD

In order to determine optimum operating conditions, we made a fly cutter by mounting a $^5/_8$-in-sq cemented-carbide-tipped single-point tool in a cutter body which had a No. 50 National standard taper shank. We set up the following cutter-design conditions and maintained them constant throughout all the runs:

Cutting diam, in.	3
Axial rake (negative), deg	5
Radial rake (positive), deg	8
Bevel angle, deg	30
Radius on corner, in.	$^1/_{32}$
Relief angle (all around), deg	7

We took from stock eight single-point tools, which were tipped with a general-purpose steel-cutting grade of cemented carbide, and ground them exactly alike on a cemented-carbide single-point-tool grinder. We used the fly cutter to mill a cut $^1/_{16}$ to $^7/_{16}$ in. deep.

We decided to make the first series of runs on the basis of maintaining a constant feed as close to 0.0035 in. per tooth as possible and to vary the speed. Operating speeds of 333, 414, 515, 636, 780, 970, 1200, and 1500 rpm were selected. We ran each one of the eight tools at one of the eight speeds, machined 200 pieces with each tool, and removed the tool bit from the fly-tool holder. We placed each tool, with sample chips, in an envelope. After all the tools were run, we compared the condition of the cutting edges and measured the width of wear lands on each tool.

We found the cutting edge remained in the best condition at a speed of 780 rpm or 613 fpm. We also found that at lower speeds the wear lands were inclined to be wider, and there appeared to be a tendency toward chipping of the cutting edges. At speeds higher than 613 fpm, the wear lands had a tendency to increase in width as the speed increased, but the tendency toward chipping appeared to be eliminated.

Next, we resharpened the eight single-point tools by duplicating the previous grinds. Particular attention was given to the duplication of the grinds. We maintained a constant speed of 780 rpm (613 fpm) and selected eight different table travels which gave feeds per tooth ranging between 0.002 and 0.010 in. Each one of the eight tools was then run at one of the eight feeds, all other operating conditions being carefully duplicated.

Contributed by the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers.

We found that feeds of 0.006 to 0.007 in. per tooth showed the minimum width of wear lands, and that, for lighter feeds per tooth, the width of the wear land gradually increased as the feed per tooth decreased. At heavier feeds per tooth, the wear land was greater, and the cutting edges showed signs of chipping due to lack of rigidity of the milling setup. The optimum speed of 613 fpm and the optimum feed of 0.006 to 0.007 in. coincided quite closely with those which we found gave the best operating conditions when machining similar materials elsewhere.

While doing this work, we also found that the rigidity of setup was of utmost importance. In other words the gib in the milling-machine table should be snug, the fixture must be rugged, the work must be clamped firmly, the cut must be taken as closely as possible to the table and the spindle of the milling machine, and the spindle end play must be kept at a minimum.

We found that, at higher speeds and feeds, the cutter operated much better when cutting dry than when cutting wet. It was interesting to note that it was not difficult to stall the lighter and the medium-sized milling machines when a fly cutter was used.

This showed the importance of having more rugged milling machines with large-sized motors, capable of pulling multitooth cutters, because it would permit the use of increased table travels provided that sufficient thought was given to material handling.

In this particular case, the fly cutter really helped to eliminate the bottleneck in cutter grinding because, when a single-point tool became dull, it could be replaced quickly on the job by a sharp one without removing the fly-tool holder. The single-point tools could be resharpened quickly by simple free-hand grinding on a single-point-tool grinder and did not require the more elaborate setup when using a tool-room-and-cutter grinder.

CONCLUSION

It must be kept in mind that the two examples outlined provide two methods for improving the operating conditions for a given job. In one case, the cutter had too many teeth, and a reduction in the number of teeth increased the chip load and improved the operating conditions. In the other case, the number of teeth was reduced to one, in order to keep within the power available, to eliminate a grinding bottleneck, to increase the chip load, and to improve the operating conditions.

HIGH-SPEED MILLING *of* STEEL *With* CARBIDES

By EINAR ALMDALE

SERVICE ENGINEER, CARBOLOY COMPANY, INC., DETROIT, MICH.

DURING the past two years, there has been an increasingly rapid adoption of cemented-carbide-tipped cutters for the high-speed milling of steels. This, coupled with the dissemination of increasing amounts of information as to results obtained and the greater availability of special-purpose carbide cutters, indicates that the trend will probably continue.

In view of these conditions, it may be said that the carbide-milling of steel has passed beyond the stage of a "future process." Its applications to date have demonstrated that carbide-tipped milling cutters make possible the operation of milling machines at speeds and metal-removal rates heretofore thought impossible. This success points out the interesting possibility that we may have to revise somewhat our conception of optimum machine performance for certain types of milling work.

GREATER MACHINE RIGIDITY NEEDED

Judging from the experiences of numerous shops where the mass-production milling of steel with carbides has been instituted, it also appears that certain modifications in the design of present-day equipment, when such changes are warranted by the type of work to be done, will make possible even better results from the use of carbides. Data gathered from many shops engaged in a wide variety of milling operations would seem to indicate that most desirable among such redesigning features are greater rigidity in those milling machines which are to be used where parts are heavy and/or cuts are deep, higher spindle speeds for application where extremely high cutting speeds can be used, and increased horsepower to take care of the higher chip-removal rate with carbides.

Although many modern milling machines are proving satisfactory when tooled up with carbide cutters, a number of simple revisions can be made in existing practices which will result in marked improvement. For instance, if the power possessed by the machine available is not quite sufficient for the maximum effectiveness of the carbide cutter, the cutter should be so designed that the proper chip load will be automatically obtained.

A practical rule of thumb for accomplishing this is to use a cutter with from one fourth to one half the number of teeth and twice the body thickness of conventional high-speed-steel milling cutters.

Carbide-tipped cutters will operate with a fair degree of success even under certain adverse conditions. However, to get the ideal performance of which they are capable, they should be designed so as to give the carbide tip the maximum amount of support permitted by the number of teeth and the necessary chip clearance.

A PRACTICAL MILLING PROGRAM AND RESULTS

In addition to designing the cutters properly, it is important to set up the type of milling program which will best fit the needs and condition of the individual plant. One procedure claimed by its users to have the advantage of simplicity and ease of application is as follows:

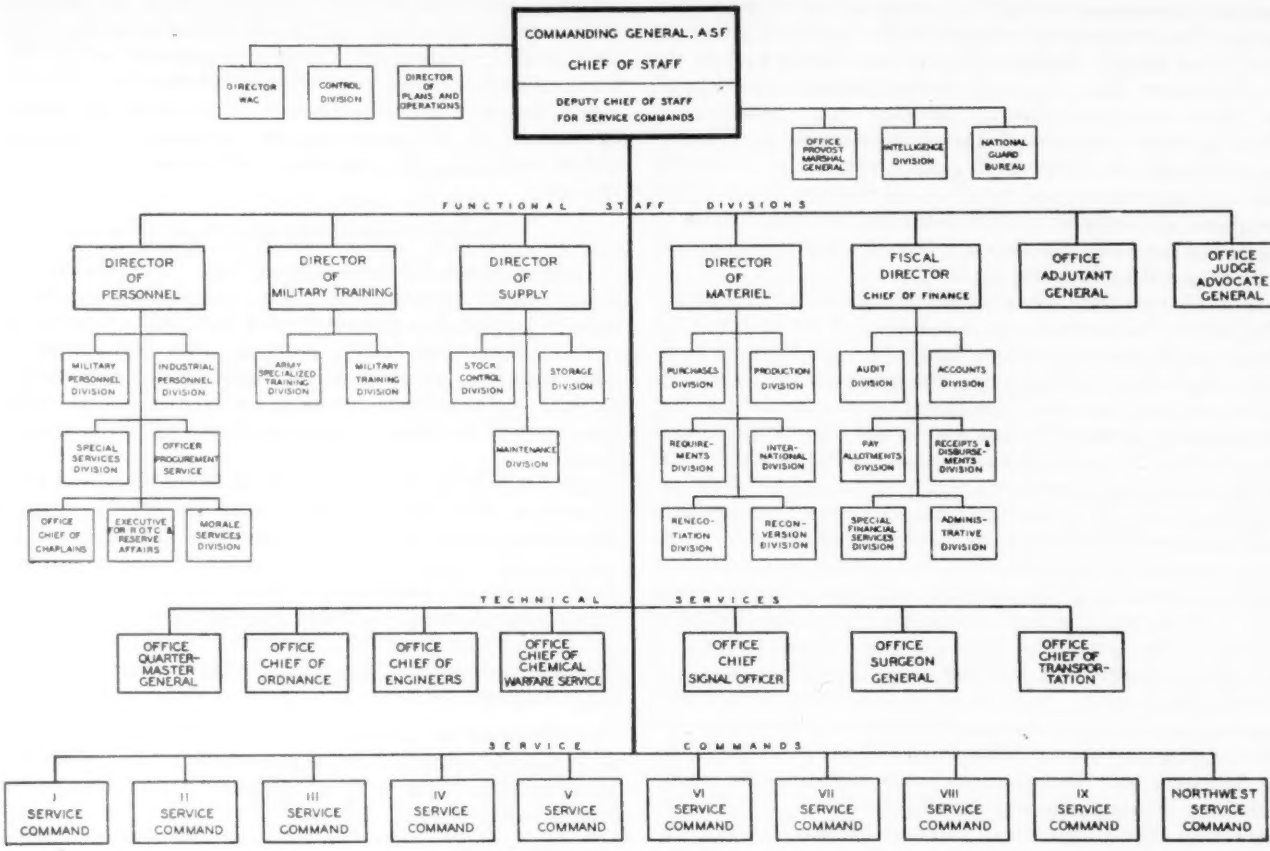
1 To go slowly at first and not tool up all machines at once with carbides.

2 To make the first series of applications of carbide milling cutters on a few simple surfaces, such as facing cuts.

(*Continued on page 326*)

Contributed by the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

ORGANIZATION OF THE ARMY SERVICE FORCES



MANAGEMENT CONTROL *in* *the* ARMY SERVICE FORCES

By CLINTON F. ROBINSON

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THE Army Service Forces is one of the largest organizations in the world under single direct management. Its functions include practically every variety of activity known to man. These range from heavy manufacturing to show business; from administration of justice to rail, water, and motor transport; from road building to hospitalization; from telephone and telegraph systems to cafeterias. Some of these activities within themselves are the largest ever undertaken in this country. Add to this the fact that Army Service Forces was formed in part by assembling old well-established semi-independent bureaus of the War Department, is less than two years old, and the problems of management can be observed in their right proportions.

The purpose of this article is to indicate briefly how management control has been applied in the Army Service Forces, what the problems were and how they have been met, and what results have been attained. It is not intended to describe techniques with a view that they might be applied to other situations.

Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers.

ARMY SERVICE FORCES ESTABLISHED IN 1942

It is necessary, first, to appreciate the condition confronting the Army Service Forces when it was born officially on March 9, 1942.

The Army had been expanding ever since the summer of 1940. While that growth was rapid, it did not approach the rate of enlargement that followed Pearl Harbor. That early expansion period, however, had revealed certain faults in the organizational structure of the War Department. For that reason the President ordered a reorganization in February, 1942. Under this new arrangement, below the level of the Chief of Staff and a General Staff, engaged almost entirely in planning activities, there were set up three major commands in addition to theaters and separate tactical commands. These three were the Army Ground Forces, the Army Air Forces, and the Army Service Forces, which at the beginning was called the Services of Supply.

The most complicated of the three from a management standpoint was the Army Service Forces because of the number and variety of its major tasks.

Initially, the biggest single job of the Army Service Forces was the procurement of supplies, except airplanes and related items. The procurement agencies of the Army had grown up over a long period. Some could trace their history back to the Revolutionary War. All had developed along semi-independent lines with little central direction and co-ordination. These agencies were the Ordnance Department, the Quartermaster Corps, the Corps of Engineers, the Signal Corps, the Medical Department, and the Chemical Warfare Service. The creation of the Army Service Forces marked the first time in the history of the Army that they had been brought under a single, fully responsible, directing head.

Some of them had more than merely procurement functions. The Medical Department was responsible for the health of the Army and directed the military hospitals. The Corps of Engineers handled all construction from Army camps to powder plants and tank arsenals. The Signal Corps operated the War Department's communications system and photographic service. Because it was clear that transportation would be one of the war's biggest problems, a new service, the Transportation Corps, was created early in 1942. Transportation formerly had been a responsibility of the Quartermaster General.

But these seven agencies were not the only ones that came under the command of the Army Service Forces. There was the Finance Department which was the budgeting and disbursing agency of the Army; the Judge Advocate General who was the Army's lawyer; the Adjutant General who supervised the Army's postal system, military personnel administration, publications, and many miscellaneous administrative services; the Provost Marshal General who supervised the military police; the Special Services Division which was responsible for recreational and informational activities for the Army. In addition, there were nine Corps Areas, later to become Service Commands, the functions of which were in the main to provide the administration and supply of Army installations and activities located within the Zone of Interior.

THE WORLD'S GREATEST BUYER

The Army Service Forces was created at a time when the War Department's job was expanding on an unprecedented scale. The Army had grown from 291,000 in July, 1940, to 1,650,000 in December, 1941. Its plans then called for more rapid expansion. By the end of 1942, the Army numbered about 5,400,000. Expansion was equally impressive in the procurement field. Total funds available for procurement of supplies, excluding airplanes, at the time of Pearl Harbor was about 18 billion dollars. In one supplementary appropriation on March 5, 1942, Congress added another 21 billion dollars and more funds were to come later. In other words, by a single enactment, Congress more than doubled the procurement program that had been developed prior to Pearl Harbor. And it was known that this was only a forerunner of what would be necessary before 1942 was over. Deliveries of rifles now are 1600 times greater than in December, 1941. Antiaircraft-gun deliveries are over 2500 per cent greater; tanks over 500 per cent greater. These figures are indicative of what had to be done for all the items of equipment for a modern Army, and for which the Army Service Forces was responsible for seeing that requirements were determined, facilities selected, contracts let, raw materials secured, and production schedules set. The number of personnel employed and the number of offices, camps, storage depots, manufacturing plants, ports for overseas shipments, reception centers, and hospitals in the Army Service Forces throughout the United States illustrates its multiplicity and size. There are more than 3500 field installations, and personnel totals about 2,250,000. Not all this is operating personnel, some being military personnel assigned for processing, training, awaiting shipment overseas, and receiving medical attention. The total operating personnel is about 1,250,000, largely civilian and engaged directly in productive work.

In short, the Army Service Forces inherited a wide variety of activities performed by many agencies and at the same time faced rapidly expanding work loads. Because of this, Lieut. General Brehon Somervell, Commanding General of the Army Service Forces, decided to provide in his office for a unit that would devote attention exclusively to measuring the progress of the A.S.F., to improving its organizational structure, and to improving the procedures and systems used in its operations.

CONTROL NEEDED FOR MULTITUDE OF DUTIES

These responsibilities were assigned to a "Control Division." It had neither operating nor directive responsibilities; rather, its sole purpose was to advise the Commanding General and to make recommendations to him and to his chief subordinate administrators. In the Control Division, the Commanding General had his own small group of fact finders calling his attention to major deficiencies and suggesting solutions thereto.

The duties assigned to the Control Division differed somewhat from those normally assigned to personnel engaged in administrative or scientific management. The concept was considerably broader. In order to secure effective control and direction over the varied and far-flung organization which had been placed under his command, General Somervell wanted an independent unit reporting directly to him which would give him, as the occasion demanded, answers to questions such as the following:

1 What are the quantitative and periodic goals for each of the major activities of the organization? What progress is being made in reaching them? Where do the delays and deficiencies lie?

2 What duplications, overlappings, and conflicts exist in the organizational structure?

3 Where and how can methods and procedures be made simpler, more direct, faster? Where is there a lack of co-ordination between them? Where is unnecessary work being done?

Because of the very size of the organization plus the need for accomplishment at high speed under the urgency of war, the orderly, cautious, planned approach generally employed in peacetime industrial or governmental enterprise would not do the job. The Control Division could not employ the orthodox concepts of statisticians in gathering figures. It could not rely solely on detailed analyses of organization nor upon the ordinary tools of industrial and management engineers, such as time studies (which are prohibited by law in War Department activities anyway) and job analyses. The Control Division's job was to show results in terms of days, weeks, months, in a work area of unprecedented size, scope, and complexity.

The problem of first importance was that of determining progress. It is end results that count in war. As important as are efficiency and cost, the primary consideration was whether or not the required number of tanks, training manuals, specialists, machine guns, bibles, trucks, socks, trained officers, and men were being turned out on time—not how they were being turned out. It was necessary to set up quick, simple, and thorough methods for measuring the progress of operations of the Army Service Forces. This meant using statistics as an important tool of management. The Army Service Forces had taken over the Statistics Branch from the Office of the Under Secretary of War. The scope of interest of this statistical unit was expanded from primary concern with procurement and construction data to include all the varied activities of the A.S.F. It was not sufficient to show month-by-month progress. It was necessary to measure that progress against carefully established progress goals. In other words, the fact that twice as many tanks were delivered in May as were delivered in April was not in itself a decisive fact. The real question was:

Was the A.S.F. meeting the military requirements placed upon it by our Army and our Allies, and if not, why not and what could be done about it?

MEASURING PROCUREMENT PROGRESS

Great stress was laid on the careful development of the program which each part of the Army Service Forces was expected to carry out. In the field of procurement, a supply program and a procurement progress report were developed. These constituted a detailed plan specifying various year-end requirements for all major items of equipment to meet the needs of our Army and of our Allies, month-by-month production schedules to meet those requirements, and a month-by-month comparison of actual and anticipated deliveries to meet those schedules. Later, end-item production schedules were translated into schedules of materials under the Controlled Materials Plan of the War Production Board, thus providing a positive measure of available materials against need. It was necessary to modify these goals from time to time in the light of changing needs in theaters of war overseas and available raw materials in this country. The progress-reporting system reflected these changes and monthly gave a balance sheet of fulfillment and failure. Major deficiencies were brought to the attention of the Commanding General. This enabled him to concentrate his efforts to take corrective action on the most important failures.

There were other fields besides procurement in which goals and statistical measures of progress were developed. In the construction program, the over-all goal is scheduled total authorized construction, and the measure of progress is the month-by-month additions to work in-place; for individual jobs, the date on which the facilities are needed, and an established monthly schedule of percentage of completion to meet that date are the goals, and the measure of progress is the actual monthly percentage of completion. Distribution of supplies is measured against the quantities on requisitions from troop units according to the priorities established by the War Department General Staff. The ratio of utilization of cargo space to total capacity of vessels measures loading efficiency. A comparative report of time in port was established for unloading of ships overseas. The number of beds occupied in a hospital against total capacity indicates what the hospital situation is. A comparison of procurement funds available for obligation with total funds obligated indicates the rate at which contracts are being let. The "noneffective" rates for soldiers and rates of occurrence of specific diseases are watched as a measure of health conditions. Days of confinement of prisoners awaiting military trial are used as a basis for determining whether military justice is being delayed. Occupied space against available space is watched as a measure of the storage situation. Quantitative measures have been found for determining progress in the training of both individuals and troop units. The average time required to pay bills is one of the factors watched in financial activities. Ship losses compared with ship construction is plotted to show ability to transport supplies overseas.

These examples by no means exhaust the list of ways that have been developed to measure quantitatively and positively whether the over-all job is being done and on time. They culminated in what is known as the "A.S.F. Monthly Progress Report." This is a document which is divided into several sections such as "Procurement," "Transportation," "Storage and Issue," "Personnel," "Fiscal," "Health" "Military Training," "Construction," and which contains the goals and schedules for the major activities of the Army Service Forces and the progress attained in meeting them.

STATISTICAL REPORTING SYSTEM DEVELOPED

In developing the statistical reporting system, the principle was adopted that the resulting reports to be of maximum value should be such as to afford a means by which top management could control and direct the activities reported upon. They should be operational. Any informative or historical value is incidental. This requirement, on the whole, has been satisfactorily met and the present report is used by the top echelons of command for operational purposes.

Originally, there was a central statistical unit to prepare reports. That unit was kept together in the Control Division while the present reporting system was being developed. Today, the central statistical and reporting service has been disbanded in favor of placing statistical responsibility with the agency of the Army Service Forces responsible for the activities on which reports are being prepared. Procurement statistics are now the responsibility of the same staff agency supervising procurement. Training statistics are a responsibility of the staff agency supervising training; personnel statistics, of the Director of Personnel. Actual preparation of the various sections of the Monthly Progress Report or parts thereof has been decentralized down through the operating agencies as far as possible to eliminate subsidiary reports. The Control Division retains over-all direction of the entire reporting system. It prepares monthly an "Analysis Section" which, as the name implies, is a critical analysis and summary of all other sections of the report and which can and is used by the very top management to grasp quickly the over-all situation and determine where corrective action is needed.

Statistical reports, if they are to be of any use, must be prompt. This requirement has been met. The largest section of the Monthly Progress Report is the Procurement Section. It shows deliveries of as many as 1600 major equipment items. It is based on data collected from every corner of the United States. This section is published and distributed to all key officials by the 10th of the month for the preceding month. Other sections of the report follow from the 10th to the 20th when the Analysis Section appears. In other words, a complete critical analysis of the status of all major Army Service Forces activities is in the hands of the Commanding General on the 20th of the month with data as of the end of the preceding month. Considered in the light of the number of different activities involved, their volume and their dispersion over the entire United States with some leading overseas, this time schedule is considered an outstanding performance.

When the various sections of the A.S.F. Monthly Progress Report are piled one on top of another, they make a stack about as high as the New York City telephone directories. It would appear that the report has substantially added to the paper work burden in the Army. Actually this is not the case. Prior to the establishment of the Monthly Progress Report, there were innumerable statistical reports in the agencies that subsequently made up the Army Service Forces. On top of all the regular and voluminous reports of peacetime, which generally had not been overhauled for years, there was added a host of new reports, both special and recurring, which were generated by the defense preparations prior to Pearl Harbor.

In this growth, there was little co-ordination and no systematic approach. There were as many as ten separate reports on the same subject. The need for certain data had long passed, for example, an elaborate forage report required from 600 sources, but reports were still being meticulously prepared, submitted, and filed. Far-reaching systems for gathering figures had been established but culminated in a report in the hands of one or a very few men instead of being distributed to all those who could and should use the information for operational purposes. Practically every key official had his own pet figures in his lower right-hand drawer and there appeared to be little concern over the conflicting figures of someone else on the same subject or the duplicating work being caused in the field. Little effort had been made to define and standardize terms. As the reporting system for the Monthly Progress Report was developed, efforts were aimed at correcting these conditions.

MONTHLY PROGRESS REPORT REPLACES 2900 FORMER REPORTS

The Monthly Progress Report took the place of some 500 former reports. In all, over 2900 reports were eliminated by July 1, 1943. The number of man-hours saved was so large that the work involved in determining them was not worth the effort. One authoritative set of figures took the place of the many conflicting sets. Reports were published in neat usable form and distributed to all who could profitably use them. The preparation of nonessential data was eliminated. Subsidiary reports and records were inventoried, reviewed, and reduced in number. A rigid control was established over all recurring reports. Requests for the establishment of new reports had to be approved by the Control Division. The criteria adopted in making such approvals or continuing existing reports was "Will any useful action be taken as a result of the gathering of this information?" So-called "control approval symbols" were assigned to all authorized recurring reports and orders were issued that no one in the organization could prepare a report unless it bore such a symbol regardless of other orders. This served to bring many unnecessary reports to light for elimination.

One of the essential tools for the management of a large complex organization is prompt standard statistical reporting of goals and progress against goals. The Army Service Forces has gone a long way in providing and using this tool. In so doing, it reduced and simplified work.

In another important field of administrative management organizational analysis, the Control Division has undertaken many projects and served in an advisory capacity to the Commanding General and his Chief of Staff in the development of the structure of organization of the Army Service Forces. The creation of a unified organization from the previously unrelated agencies, which were pulled together in the Army Service Forces, was a major problem. Duplications, questions of jurisdiction, overlappings, lack of clearly defined missions were on every hand. Organizational changes have corrected many such cases. To some degree, however, they continue to arise as the importance of certain activities decreases or increases. Today, the organization of the Army Service Forces, through a process of evolution, has reached a point of relative stability. It still creaks in spots, but on the whole is running smoothly.

CORPS AREAS REORGANIZED AS SERVICE COMMANDS

The reorganization of Corps Areas into Service Commands is a major example of the organizational projects undertaken. When originally established in 1920, the nine Corps Areas in the United States were the major tactical commands of the Army. Little by little their authority had been reduced until by March 9, 1942, when the War Department was reorganized, they retained only certain supply and administrative functions. Even these were poorly defined. Presumably, the Corps Areas ran the posts, camps, and stations where ground-force troops were stationed for training. Actually, their responsibility for performance of service to such troops and in other activities such as internal security, processing of draftees, was anything but clear. Lines of command were hazy. Did the ordnance officer on a post report to the post commander or to the Chief of Ordnance in Washington? Did the disbursing officer report to the commanding officer of the post or to the Chief of Finance in Washington?

Although tactical responsibilities had been taken away entirely from the Corps Area Commanders, their Headquarters continued to be organized along tactical lines. The number of units reporting directly to the commander were entirely too many to be controlled and directed by one man. In one Headquarters alone, there were 32 independent branches reporting to the Commanding General. There was much overlapping and duplication of activity, especially in the handling of civilian personnel and finances.

This situation necessitated corrective action if these agencies were to be effective components of the Army Service Forces. The approach to the problem was to make a thorough investigation of the actual organization and operations in two Corps Area Headquarters. Based on these data and other considerations, the role that the Corps Areas were to play in the Army Service Forces was determined. It was decided to make each Corps Area, with name changed to Service Command as being more descriptive, the operating agency for all activities of the Army Service Forces in the Area, except procurement, new construction, and certain phases of transportation and storage of supplies which could be better handled under existing conditions directly from Washington. A specific list of functions to be performed by each Service Command was prepared along with a statement of authority with respect thereto. A standard organizational structure to carry out these duties was evolved. The initial step in putting the new organization into effect was a three instructional conference with all Service Commanders.

A major policy upon which organizational decisions were based was the decentralization of authority to the greatest extent possible. In peacetime, much of the work of the War Department in Washington was of an operating nature. For example, the Office of the Chief of Finance in Washington was able to examine every single voucher in payment of War Department obligations. Disbursing officers sent all their vouchers after payment to Washington for that check. In wartime, such an arrangement could not be justified. In consequence, four regional accounting offices were set up where all vouchers could be examined. The policy was continuously stressed that Headquarters offices in Washington should devote themselves to broad questions of policy and to supervision of activities, leaving full responsibility for performance to officers in the field.

The Control Division undertook a major campaign to unearth and correct situations where approvals and other restrictions imposed by offices in Washington were delaying and hampering action in the field. In the course of less than three months over 600 such cases of importance were corrected. Many approaches have been used in attacking the problem of improving the systems, procedures, and methods of the Army Service Forces. In general, they have been along broad lines with a view to covering much ground in a hurry. There was so much that could be done without getting into the details of operations, there was such a need for speedy results (and the activities to be covered were so many and so large), that refinements, job analyses, time-and-motion studies were not justified. The following examples are illustrative of the work that has been done and is continuing in this field.

FIELD FORCES SUGGEST OPERATIONAL IMPROVEMENTS

At one stage all field units of the Army Service Forces were directed to submit recommendations on policies, regulations, restrictions, and approvals which were imposed by higher authority and which were hampering and delaying action and causing unnecessary work in the field. Directives were issued to the major organizational elements of the Army Service Forces on March 1, 1943, that operations be reviewed in this light and recommendations submitted through organization channels to the Control Division. The management and follow-up on this program in the Technical Services and Service Commands was placed in the hands of the respective control units. Intermediate headquarters were allowed to comment on recommendations of their subordinate units, but were not permitted to kill any suggestion on the way up. There were 4255 proposals received in response to these directives. Very few were trivial; practically none was silly. These recommendations were broken down according to type as follows: Nonessential records, 1505; nonessential activities, 1282; decentralization, 1156; conflicts and overlappings, 312.

Thirty members of the Control Division were assigned to the job of analyzing these recommendations, co-ordinating with interested agencies of the Headquarters, Army Service Forces, and initiating corrective action where appropriate. Sixty per cent of the recommendations submitted were favorably considered and corresponding corrective changes made in existing policies or regulations.

A summary of the program giving the nature of the action taken on each recommendation adopted was distributed to all echelons of command in order that complete benefit from the program might be obtained.

Another approach to the problem of improving methods was the complete overhaul of existing important procedures which occur in about the same form in multiple spots throughout the organization, such as shipping procedures, requisitioning procedures, personnel procedures, payment procedures. Work along these lines resulted in detailed manuals applicable to the entire organization.

A procedures committee of the Army Service Forces was formed for carrying on this phase. Its executive and working members are part of the Control Division. Other members are drawn from the appropriate units of headquarters, concerned in the activities being covered, to secure co-ordination of information and decision with minimum delay.

Probably the best example of a procedures committee project is one covering the requisition, receipt, issue, storage, shipment, and accounting of supplies and matériel. This project was initiated because many field installations requested relief from complex peacetime regulations and procedures. Under the leadership of the Control Division, representatives of interested Staff Divisions, Technical Services, and Service Commands commenced work on this project early in April, 1943. The first analysis indicated that the problem had many facets, each of which could be considered a major subproject. Some immediate relief was given through changes involving clarification of property responsibility, elimination of property accountability at intransit points on shipments consigned overseas, elimination of nonessential copies of documents mailed to Service Command Headquarters for auditing purposes, elimination of the "accomplishing of shipping tickets," and the preparation of post cards acknowledging receipt of shipments.

Unless there is a clear conception of the magnitude of the operations of the Army Service Forces and the tremendous volume of paper work involved in its administration, these actions may not appear to be significant. Yet the elimination of property accounting at holding and reconsignment points and at ports of embarkation saved over 300 clerks. The elimination of the auditor's copies of shipping tickets saved the preparation, mailing, handling, and filing of six million pieces of paper per month. The preparation, mailing, and filing of $2^1/_2$ million post cards was saved monthly and three million additional copies of shipping tickets were saved by eliminating the "accomplishment" of these papers.

The development of procedures which cut across the activities of many agencies performing similar functions requires detailed studies of operations at a number of typical installations, the careful analysis of findings, the development of tentative procedures, the installation of tentative procedures on an experimental basis, and finally after the procedure has been in operation long enough to satisfy all concerned of its practicality, it is extended to other similar installations. During the period a procedure is under experiment, a manual is in process of preparation for publication. When the manual is released for distribution, the procedure is ready for installation throughout the Army Service Forces. Several of these manuals have been published. Graphic presentation is employed to the greatest extent practicable so that supervisors may use it for training new employees with a minimum of overtime required for instruction.

SHIPPING DOCUMENT SAVES PAPER WORK

Probably the most far-reaching procedure developed to date by the procedures committee is the War Department shipping document. This employs the principle of preparing a sufficient number of copies of a single shipping document at the point of origin to satisfy all requirements of the consignor, intransit shipping agencies, and the consignee. Its adoption involved the training of employees at 157 depots and nine Ports of Embarkation. In addition to providing accurate information on the contents of shipments to the consignee whether in this country or overseas, a sufficient number of copies of the shipping document accompanies each shipment for use as tallies-in and tallies-out, packing lists, and shipping tickets, thereby eliminating the preparation of these papers and expediting the movement of shipments through the port. A single document in a standard form has replaced a great number of uniform and local forms. The effects have been so far-reaching that it has been impractical to measure the savings that have and will ensue although they are known to be enormous.

In studying the flow of copies of the War Department shipping document through the nine ports, it was found that the number of copies requested for use at ports ranged from 11 to 44. Obviously, something was wrong at the port requiring 44 copies. Investigations led to a reorganization and simplifications of work that eliminated over 3000 employees. Not all of these were directly attributable to the War Department shipping document but the document started the chain of improvements that made this result possible. This is an extreme case, but worth-while savings in manpower have been made at all depots and ports.

IMPLEMENTING A WORK-SIMPLIFICATION PROGRAM

Another major approach to procedural simplification, involving the development of techniques in the self-appraisal of local procedures was accomplished by the creation of a "work-simplification" program. Experienced officers formerly engaged in industrial engineering spent considerable time in adapting and simplifying techniques employed by industry with a view to developing a simple, understandable technique which could be utilized by control officers throughout the A.S.A., as well as by operating executives. After study and tests, such a technique was evolved and a manual prepared for wide distribution throughout the Army Service Forces. The basic tool in the work-simplification technique was a "process chart" based on charts similar to those already used in business, but simplified to the point where four symbols (operation, transportation, storage, and inspection) were used to replace a large number normally employed by industrial engineers. In other ways, the process chart was trimmed down to its basic essentials in order to make it salable and understandable to the nonexperienced individual.

The program was initiated by a presentation of the technique at a meeting attended by Technical Service Control officers. This was later followed by visits to each Service Command for presentation of the program to the key members of the Headquarters staff as well as the control officers. After this presentation, buttressed by personal explanation and demonstrations by officers from the Control Division of Headquarters, Service Commands and Technical Services conducted meetings of their own among their major operating elements. This process was carried down to the level of field installations.

The program got under way March 1, 1943, and by July 30, 1943, there had been over 5000 work-simplification projects conducted within the Army Service Forces, involving organizational units containing almost a quarter of a million people. Average saving in personnel requirements as a result of these projects was over 10 per cent. While this was not as large as would have been obtained by experts, the rapid application of the technique on a tremendously broad scale necessitated a compromise in the quality of performance.

This program illustrates the general approach, already described, to disseminate a program over a vast organization in a short period of time to obtain wholesale results. To make sure that the benefits of such improvements as have been described were actually obtained in personnel reductions, a personnel control system was developed and placed in effect.

EMPLOYMENT CEILINGS FIXED

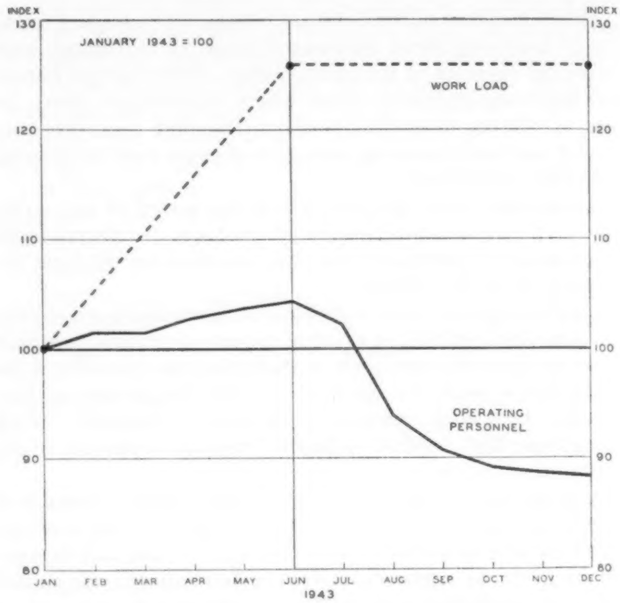
All operating personnel was placed under an allotment system so that every element of the command had to justify with care its civilian and military employees. In peacetime, budgetary controls had provided all necessary personnel control. In wartime, with appropriations made for two years or longer, budget controls did not provide effective personnel control. For that reason, a separate personnel allotment system was set up and definite employment ceilings were fixed for all parts of the organization. These ceilings could not be exceeded without approval by the Commanding General. The ceilings established were considerably less than the existing employment. Although the work load has expanded and is still expanding, there are actually 180,000 fewer employees in the Army Service Forces today than six months ago. Over 8000 of this reduction occurred in Washington. The Army Service Forces takes pride in being one of the few Federal agencies which during the war has not only stopped the increasing employment of personnel but has actually reduced employment in spite of an expanding work load.

The "control" work of the type here illustrated, applied over the vast organizational area of the Army Service Forces in a period of a few months, could not have been performed by one group located at headquarters, regardless of its size or the capabilities of its personnel. It was apparent that the functions of control had to be decentralized. Units had to be created in as many places as were necessary to cover a wide field in a short time. It was soon recognized that the adoption of recommendations evolved from control work would be speeded by having that work done at a point as close as possible to actual operations. Consequently, one of the first steps undertaken by the Control Division was the establishment of control offices under the Chief of each Technical Service. A close approximation of a control office already existed under the Chief of Engineers and the Quartermaster General. In the spring of 1942, others were established under the Chief Signal Officer, the Chief of Transportation, the Chief, Chemical Warfare Service, the Chief of Ordnance, and the Surgeon General.

DECENTRALIZING THE CONTROL DIVISIONS ACTIVITIES

The nine Corps Areas were reorganized in the summer of 1942, into Service Commands and were assuming an increasing burden of the operating duties of the A.S.F. In the reorganization, a Control Division was established in the Headquarters of each Service Command to fulfill basically the same mission as the Control Division at the Headquarters of the A.S.F. Later, the need for further decentralization was apparent, and control units gradually were built up in the larger field installations, including ports of embarkation, depots, and large posts and camps. Today there are approximately 250 control units at all levels of command within the Army Service Forces, engaged, within the scope of the jurisdictions of their respective commanders, in fulfilling the same mission as the Control Division of the Office of the Commanding General, Army Service Forces.

This network of control offices, all engaged in checking on progress and recommending, to their respective commanders, methods of improving operations through improvements in organization and simplification of procedures, made possible the accomplishment of programs on a broad front in a short period of time. Standard projects to be undertaken by all control units were developed. For substantial periods of time, all control units were simultaneously engaged in identical work on a uniform basis. It is safe to say the accomplishment of the control mission, to the degree to which it has succeeded in the Army Service Forces, would have been impossible under any other arrangement.



INDEXES OF TOTAL OPERATING PERSONNEL AND WORK LOAD, ARMY SERVICE FORCES

These standard projects helped in another way. They put control units to work on activities closely related to their primary mission. The speed with which these units were established, the obvious impossibility of conveying the purpose and working methods for control offices satisfactorily in written form, and the impracticability of the representatives of the Control Division personally visiting and helping these control units to become established; all of these factors created the distinct danger that these units would become engulfed in miscellaneous activities not related to control work or that their efforts would be dissipated in several other fields. The use of standard projects in which control units at all levels were simultaneously engaged insured that these units would get started on the right foot. As time went on, the necessity for such standard projects decreased as the chiefs of control units became familiar with the nature and purpose of the work.

SYSTEMATIZING TECHNIQUE FOR 250 CONTROL UNITS

The development of techniques and approaches by the Control Division for implementation by the 250 control units throughout the organization necessitated codification of these ideas in some systematic form. As a result, manuals on "control" were prepared and issued. These have served in many quarters within the Army Service Forces as basic texts. Their aim has been to present clearly and simply without frills the fundamental elements of the job. It is interesting to note that, although these volumes were prepared rapidly, even hurriedly, on almost an emergency basis, hundreds of requests for them have been received from outside the A.S.F. as a guide in administrative management work.

The whole concept of so-called "control" work in the A.S.F. has been one of critical self-analysis. Probably no attempt on such a broad and objective scale has ever been made before by an organization to find its own deficiencies and correct them. The effort has been one of trying to get every echelon of the organization, from top to bottom, asking these questions with respect to itself: "What is the required end result?" "Are we ahead or behind?" "Is there an easier, simpler, cheaper, or faster way to produce the end result?"

And then, if the answers are unsatisfactory, to do something about it.

INDUSTRY'S RESPONSIBILITY *for* POSTCOLLEGIATE EDUCATION

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ENGINEERING TO WIN THE PEACE

It may be more difficult to win the peace than to win the war. The suggestion has been made that the United States of America will not only have to pay for the war but also for postwar feeding and policing the world. Whether we shall be financially capable of carrying this burden is quite a question. We certainly can't carry it unless we all work. Therefore we must have full employment.

In the postwar period we can have prosperity if we have normal full employment. If we can employ 57 million people 40 hours per week at present rates of pay, the national income should be well over 100 billion dollars. With an income of this sort it will be more nearly possible to pay the taxes, to liquidate the cost of the war, to police the world, and to feed the world to some extent. If we have unemployment such as we had in the 1930's, it will be impossible to do any of these things without going bankrupt.

At present we have more than full employment. One answer is that it is a result of the war. But another is that the war has stimulated a great deal of invention and development. It is doubtful whether ever in the history of the world there has been such a rapid and intensive development and initiation of production of new things. The result is a national income of about 175 billion dollars. At the bottom of the depression the national income was only about 50 billion dollars, and at this time, because of lack of confidence, business was not inventing, developing, and initiating the production of new things.

People who have studied the matter say we have never had full employment without new enterprises. We have to have an expanding economy. Experience indicates that we are prosperous only when about 20 per cent of the national income is being invested in new enterprises.

In 1939 President W. E. Wickenden, of the Case School of Applied Science, wrote an article[2] "The Young Engineer Facing Tomorrow," which sums up the necessity for the development of new products as follows:

> Every engineer knows that permanent gains in wealth and leisure are the by-products of rising efficiency and cannot be created by government subsidy; that the way to cure unemployment is to create more jobs through research, thrift, and enterprise, by development of new products, by creating new industries, and by translating technical advances into reduced prices and wider markets. One quarter of all our employment today is said to be in industries which did not exist before 1880.

We can't have full employment if we all make the same things, because the markets for these things will become saturated. Therefore we must have ingenuity and inventiveness to think up new things which people will want to buy. Without good engineers, new successful enterprises are not possible. It takes engineers to invent, design, develop, and put new products into production.

PRESENT TRENDS

The supply of engineers has been interfered with in two ways by the war. A great many engineers have had their college courses interrupted, and those who have been allowed to remain in college have been in accelerated courses. Although these accelerated courses cover many subjects rapidly, there is a feeling that the students are not able to absorb and thoroughly understand them when they are pushed through in such a hurry. There is danger therefore that the men who have obtained their engineering training in these courses may tend to be handbook engineers.

There is grave danger that the continuity of engineering education in the colleges will be broken because recent selective-service directives say that all the engineering students must graduate by June 1, 1945. If the war should continue beyond that date, it looks as though the colleges would have to close because the Army Service Training Program is being abolished.

The effect of the war has also had serious consequences on the attitude of young people toward education, and college education in particular. The reduced time spent in college under the accelerated programs has led many people to believe that a four-or-five-year college course is unnecessary and a great waste of time.

The engineering graduate today is thus greatly handicapped compared to his predecessor of a few years ago in analyzing any engineering problem from fundamentals. Consequently, the native ingenuity of but few men in college during this period has been stimulated or developed by a basic understanding of engineering fundamentals. Nor have such students been encouraged to think for themselves in the rush of absorbing detailed knowledge in a very limited field.

During the postwar period considerable pressure may be brought to bear on the colleges by many people to continue the accelerated program. But such people fail to recognize the loss to the national culture and the lack of all-round ability of the engineering graduates which such a program produces. Not only have subjects been covered very rapidly in the accelerated program, but also only subjects relating to specialized fields have been covered at all completely.

The engineering colleges should return to at least a four-year program interspersed with vacation periods during which the students could work and get practical experience.

Industry must play its part in offering opportunities for work to these college students in their vacations. This would be more convenient for industry if the colleges could arrange it so that all the students would not be looking for work during the same three months of the year. There should be a greater expansion along the lines of co-operative courses where students work part time in industry while they are going to school.

EDUCATIONAL RESPONSIBILITY

Not only will it be necessary in the coming months for colleges to recognize and appreciate the limitations of the accelerated program but they must in addition, with industry, emphasize to the country at large the necessity of returning to basic college curricula as rapidly as possible.

During the war period many professors have transferred from

[1] Manager, A.S.M.E.

[2] *Electrical Engineering*, May, 1939.

Contributed by the Committee on Education and Training for the Industries and presented at the Spring Meeting, Birmingham, Ala., April 3–5, 1943, of The American Society of Mechanical Engineers.

the colleges to industry. In the postwar period industry must feel the responsibility for letting some of its best engineers take teaching positions in the colleges. It would be a good thing for the profession if more opportunities could be provided for the interchange of staff members between colleges and industries. This could be done by summer work in industry for college professors, or even better, perhaps arrangements could be made for college professors to spend "sabbatical years" in industry.

In order to carry on the type of engineering which will be needed in the postwar period, we must have a supply of young men whose native ingenuity has been encouraged and developed, who understand the basic fundamental principles, and who can think for themselves.

If they are not getting this kind of training in college, then it is more than ever necessary that industry for its own sake furnish such education and opportunities for development to the young men whom they recruit.

Such courses will be invaluable as refresher courses to young engineers returning from the armed forces.

Even in ordinary times, postcollegiate education within industry is very valuable. The college can teach physics and mathematics and the fundamentals of engineering, but the application of this fundamental knowledge to engineering problems can be done more convincingly in postcollegiate courses in industry.

POSTCOLLEGIATE APPRENTICESHIP

Every executive must be an educator. In fact, he can't be a good executive unless he is an educator. In the broadest sense, an executive becomes effective when he educates his assistants to do the things he wants done, in the way he wants them done. In fact, he becomes even more effective when he can educate his assistants to originate spontaneously and carry forward desirable enterprises without specific instruction.

It is sometimes said that only large industries can run these educational systems. To be successful, a small company must have at least one engineer who understands his engineering. Such a man should also have leadership ability which would include the desire and ability to educate others. Time spent in educating others will not be wasted, but will be returned manyfold in the more intelligent help which his assistants can render him. It makes one think of the Bible verse—"Cast thy bread upon the waters and it will not return unto thee void."

Someone may ask about the company which hasn't even one good engineer. Shouldn't the college supply men trained for such positions? It seems to me absurd to think that the colleges can turn out an engineer capable of going into a company where there are no good engineers and suddenly take responsible charge of engineering activities. The engineering societies very rightly insist on practical experience before a young man is considered a full-fledged engineer, and the state licensing boards also require practical experience before a man is placed in charge of engineering work. Therefore, if a small company hasn't even one good engineer who is capable of educating his associates, they cannot hope to supply this need directly from the colleges but should obtain some older man who has had both education and practical experience elsewhere. In other words, there is no substitute for apprenticeship in the widest best sense of the word, in engineering as well as in mechanical trades.

"FOR INSTANCE"

When our company was first formed, there were no electrical engineers available to test, install, service, or even operate the electrical equipment. The company was thus forced in the very beginning to start an educational system. Young college men were given practical experience in our "Test" and training for leadership in the responsibility of running this Test. Over the years about 15,000 men, who have come to us fresh from college, have participated in the Test course. Many of them are still with the company, but many others are holding positions of leadership throughout industry.

About twenty years ago it became evident that the four-year college course was not enough. The colleges could teach fundamentals, but we had to show the graduates how to apply those fundamentals to a great variety of practical problems. We founded the Advanced Engineering Program in which a carefully selected group of men are given one to three years of additional education. Four hours a week are devoted to classroom lectures and recitations, in preparation for which considerable outside work is required. The courses are revised continuously to keep abreast or ahead of the art. Many of the lectures have been published in books which are being studied all over the country.

The success of our Engineering Educational Programs is due almost entirely to the philosophy behind them rather than to the technical material presented. Selection for the Advanced Engineering Program is based principally on knowledge of fundamentals and ability to apply them to simple problems. It is therefore essential that the colleges provide training in the fundamentals of engineering rather than in specialized design. New designs, to be successful, must always be based on the fundamentals of engineering rather than on previous design. We therefore believe that it is more important for the men of the program, who will be our technical leaders of the future, to have a broad knowledge of the fundamentals underlying all engineering rather than detailed knowledge of any specific design.

The classwork of the program, therefore, consists of a series of weekly engineering problems, each one of which may require about twenty hours of outside work. Each problem is complete in itself, although it generally involves more than one branch of engineering. The emphasis is upon a correct solution rather than upon the knowledge of any specific method, and the men are encouraged to develop their own method of solution if it will save time or present a better physical picture of the process involved. For example, training in mathematical manipulation and concepts is distinctly limited to those which have direct application in the solution of a specific engineering problem, the objective always being the most simple and direct solution.

Although the broad outlines of the program and its objectives have not materially changed since its founding twenty years ago, the material content has been revised every year to keep pace with the advances in engineering. We are extremely fortunate in this connection to have available an almost unlimited supply of problems which are directly related to production and design. There is therefore no question about the importance and relevance of any material which is given in the program. It is always directly involved in the solution of a practical engineering problem.

The company believes that men must work while they learn. They thus combine real experience with education. During the first year of this program the men do productive work on Test. During the second and third years they are circulated on assignments of at least three months to various engineering departments and to the Research Laboratory where they do useful engineering work. They thus come in close contact with many of our older engineers and some of our research scientists, absorbing a perspective, a point of view, and gaining a balance which could not be obtained in any one department. The rotation also helps spread up-to-date scientific information throughout the company.

TRAINING FOR LEADERSHIP

The Advanced Engineering Program also provides a unique type of training for leadership. The instructors of all the classes, whom we call supervisors, are themselves recent gradu-

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BIOMECHANICS

A New Approach to Airplane Safety

By CHARLES MURRAY GRATZ, M.D., F.A.C.S.

NEW YORK, N. Y.

LOSS of life in crash landings, or "ditching," of aircraft at sea and on land can be and is being reduced. Our Allies and we ourselves are now perfecting ditching procedures and techniques. The safety engineering of the airplane is now being co-ordinated with rescue and early surgical treatment of the survivors of crashes. Mr. Hugh De Haven[1] has presented authenticated records of survival under seemingly impossible circumstances. His findings have been carefully analyzed. When such facts are combined with biomechanical study of the human mechanism of survival and applications of it are made with intelligence, avenues are cleared for further accomplishments. It is estimated, for example, that 50 per cent of the lives now lost in the intermediate type of life-or-death crash can be saved. Second only to the winning of the war is the saving of the lives of combat personnel.

In order to accomplish significant results, the airplane and its human cargo should be considered as a unit. Crash loads are transmitted from the point of impact through the airplane structure to the human body. In a crash, both structural and human failures end with either one of two results: Crash loads are either reasonably absorbed or they are fatal.

The mechanism of structural defense of the human being is called into action at the split second of crash. This is the safety bottleneck which is daily costing lives. The remedy is twofold: The immediate problem of safety is the design of structural parts to afford local protection at the point of contact with human tissues. The ultimate problem is the basic co-ordination of human defenses with structural protection, particularly within the cockpit of the airplane.

The strength of aircraft structures is known or can be reasonably estimated by engineers. Fortunately, surgeons have used engineering techniques and have determined accurately the amount of stress human shock absorbers can safely tolerate. The physiological range of the elastic properties of human fibrous tissues so determined compares favorably with that of many structural materials. The exchange of engineering and surgical techniques has increased safety in surgery, because two filters have been used to crystallize facts before acceptance and application.

Heretofore, shearing stresses in human tissues had received but scant study. Shear is one of the most important variables in surgery and its study has reduced the percentage of complications in surgical procedures. Shear must also be avoided in selecting optimum positions of the body to withstand crash and landing stresses. The data prepared and used for a decade in surgery of human locomotion have now been made available for biomechanical safety engineering. This knowledge of the biomechanical defenses of the vital portions of the human mechanism clarifies our consideration of the airplane and its human cargo as a unit. The maximum co-ordination of man with machine begins at the point of contact of the structural members of the plane when they come in contact with human tissues in crashes. Data are available for basic co-ordination from the point of impact of the plane to the vital portions of the human body.[2]

Successful co-operation between surgeons and engineers leads to an exchange of techniques known as biomechanics. Biomechanics is a division of the larger sphere of biological engineering. The term was used in describing the original mechanical heart. Our Russian allies have successfully co-ordinated surgical and engineering studies. Their perfection of the artificial heart, successfully used in the revival of dogs for periods up to 15 minutes after cessation of circulation, has received due recognition. The late George W. Hawley, G. B. Karelitz, and Dan Everett Waid were among those who founded the first surgical biomechanical group which later led to the formation of the present Biomechanics Committee. The many applications to safety in surgery were successfully launched and commissioned by this group. Knee-action cars and airplane landing gears are examples of principles in the mechanics of the human body successfully applied in machine design in industry.

Injuries sustained in crashes by vulnerable and vital tissues of the human body are the result of physical forces that fortunately lend themselves to analysis. Once such forces are analyzed, studies can be applied to control and minimize their often fatal results.

The damage to the human body varies with the manner in which the crash loads are imposed on it. Head injuries occur in 90 per cent of major crashes. Injuries to the extremities are all too frequent. The human torso has a split second for adjustment to crash stresses after the head and extremities are involved with resultant saving of tissue damage to the torso. The human spine and the posterior division of muscles and fibrous tissues supporting it are frequently able to withstand crash loads with astonishing success. The open field for first improvement lies in the safety design of the equipment and surfaces within the airplane cockpit against which the head and the extremities of personnel first crash. For reasons later stated, the pilot and co-pilot are the most vulnerable occupants of the cockpit.

Human tissues are, by their very nature, most adaptable to protection by safety design. Their protection may be divided into two parts: (1) Features which are protective (crash-pads, helmets, safety belts, and the like), and (2) the elimination of projections and sharp corners which may cause serious tissue damage, particularly to the human head. Hazards in the forward cockpit that cause head or other extremity injuries should be either eliminated or streamlined for safety.

The pilot and the passengers present different problems, the latter having a choice of position in the cabin when ditchings become inevitable. The former must face the instrument panel as long as the plane is aloft. In certain ditching procedures, the passengers are advised to face the rear of the cabin and brace their backs against a bulkhead or partition. In this connection J. M. Clark, a member of the Biomechanics Committee, who has been engaged in the study of patents in this field, has called attention to British Patent Specification 554,720, in which Z. J. Pekárek describes devices for the safety of flying personnel during crash-landing of an aircraft.

[1] "Mechanics of Injury Under Force Conditions," by Hugh De Haven, MECHANICAL ENGINEERING, April, 1944, pp. 264–268.

Contributed by the Biomechanics Committee of the Aviation Division and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] A Bibliography on this subject has been prepared by the Biomechanics Committee for private distribution.—EDITOR.

The foregoing considerations constitute the emergency portion of the biomechanical solution of the bottleneck in aviation safety. Athletics, industry, and the experiences of warfare have led to methods to protect the human head. Automobiles have been designed to incorporate safety features in their interiors. In fact, just prior to the war, the automobile industry made safety a major feature of its advertising campaigns. The optimum position to be assumed by paratroopers in landing has been fairly accurately determined. Engineers in the field of aviation biomechanics are merely applying horse sense in getting such a program for aircraft safety under way. Recommendations are being formulated for this portion of the safety program.

Co-operation between surgeons and mechanical engineers working together to improve and interchange their techniques during the last decade has already been referred to. The role of the skin and the tensile properties of bone in relation to crash protection can be studied by methods which have proved successful in the studies of human fibrous tissues.

Aircraft biomechanical studies were started in the combat zone of the Pacific theater of operations in June, 1942. A memorandum with recommendations was sent to G. B. Karelitz on August 7 of that year. This memorandum, on file with the Committee, includes a footnote giving due credit to combat personnel who were associated with the author.

A group of combat pilots attached to our Pacific carriers prepared safety equipment which saved eight out of ten pilots when they crash-landed during the Battle of Midway. This saving of life gave a great impetus to safety study among the aircraft-carrier pilots. One of the members of the afore-mentioned surgical biomechanical group became interested in this type of preventive surgery. It so happened that the two groups got together at a Naval Air Station in the Pacific, pooled their respective experiences, and decided that they would do something definite about pilot safety. All equipment for rescue work was thoroughly checked, timed trial runs were made, and a safety program was launched. The development of methods that have saved and are saving lives are covered in memoranda on file.

The personal experiences of members of this committee, the detailed account of survivors of crashes, and the work of our Allies, particularly the British and Russians, constitute a foundation on which we are safely building and finally hope to perfect even the more difficult portions of the program. The precision with which facts from different parts of the globe dovetail shows the firm foundation and accuracy of our approach. Safety engineering should start with the blueprint stage of airplane design and should include equipment and procedures used in ditching.

The Army and Navy have large central organizations in which engineers and doctors investigate all crashes. The human injury and the portion of the airplane structure which caused it are made part of the record. Co-ordination of crash data at the scene of the accident helps in preventing future accidents and lessens their damage. A unified safety program is thus not something for the future but is now actually under way. The groundwork is being laid on which aircraft safety can be further advanced when combat hazards are no more.

Crash landings cannot be entirely avoided. Safety advances when the effect of crash landings on the occupants can be minimized or eliminated. The loads in a crash are as serious on the human body as they are on the aircraft structures. The most serious safety bottleneck lies between structural elements and human elements, particularly the head. Human heads are irreplaceable. A unified plan to reduce human breakage by the increase of structural protection is the objective of the Committee's program. In this program the plane and the human cargo are considered as a unit.

Planned safety for reducing the severity of loads on the human body in the occasionally unavoidable crash landings of aircraft will increase public air-mindedness. Safety aircraft design will save the lives of combat aerial personnel. Safety design features that get the acid test in military training and combat will certainly be incorporated in the postwar plane. Safety in aircraft as in cars will be remembered long after speed and daring are forgotten.

Industry's Responsibility for Post-Collegiate Education

(Continued from page 312)

ates of the program. They are given complete responsibility for the organization and administration of their respective classes and are encouraged to inject into the class any improvements which they, as students the year before, had felt would benefit the class. Normally these men supervise a class for only a single year, and they therefore approach this work with intense enthusiasm and with the knowledge that they have only one opportunity to contribute to the program the material and teaching methods which they believe most important. Supervising thus becomes a creative opportunity for each supervisor to take the material which he received as a student, revise and improve it, and pass it on.

Naturally such young men do not have the experience and background that certain phases of the program require. They therefore depend on the experts scattered throughout the company for such material. In a single year more than 66 such specialists have lectured to the Advanced Engineering Program in addition to the members of the staff. However, complete responsibility for each class still rests with the supervisor and he thus gains outstanding leadership, ability, and experience in handling personnel problems.

A leader must understand human relations. Some people think this subject can be learned only by experience. It is seldom included in a college curriculum. It is for this reason that, when hiring college graduates, industry is interested in their extracurricular activities.

We believe a young man can gain more from his experience in human relations if his interest in this subject is stimulated by discussion. We believe in making young men conscious of the feelings and reactions of others. Engineering projects are so big that it is always necessary to work with others. The results of a group working together with real teamwork are much greater than the sum of individual efforts. In our discussion groups on human relations we emphasize determining the problem, finding the solution, and selling the solution. Practice in public speaking is included. The discussions also emphasize the importance of helpful attitudes toward others.

RESULTS

Over 750 men have graduated from this program, and most of them are still with the company—forming the shock troops for attack on the company's most difficult technical problems. When the war emergency started, we thus had the personnel and organization of a technological clinic consisting of exceptionally well trained men who had not been trained narrowly in only one specialty but who had been rotated from department to department and thus were in the habit of tackling new jobs. These men were transferred directly from the program and from refrigeration, air conditioning, and other peacetime jobs into war work, and formed the spearhead of many technological advances, and the technical foundation of those greatly expanded divisions—radio, superchargers, and armament control.

It is believed that the broadly trained graduates of these programs can readily readjust themselves in the postwar period to help in the most important task of beating swords into plowshares, thus helping to keep employees on the pay roll and to furnish employment to returning servicemen.

AVIATION *and the* FUTURE

By R. E. WHITMER

TRANSCONTINENTAL & WESTERN AIR, INC., KANSAS CITY, MO.

ECONOMIC experts estimate that 10 years after the war, the number of passengers now being carried annually by the domestic air lines will have increased over 1500 per cent. This may appear unreasonable and yet, in 1931, 470,000 passengers were carried by the domestic air lines of the United States, while in 1941, 10 years later, over 4,000,000 passengers were carried. This represents an increase of 764 per cent. There is reason to believe that the rate prevailing before the war will not only be maintained but augmented because of the technical advances made in the art as a result of the accelerated war program. The larger and faster multiengine airplanes which are in use in war zones today will be available in advanced design for commercial use in the future.

Furthermore, there will be a vast market for private planes. According to Civil Aeronautics Board records, in 1930, there were over 9000 such planes, and by July 15, 1941, more than 22,000 private planes were in operation. Projecting this trend into the future with the added impetus given to aviation by war developments, and especially because of the vast pilot-training program, an optimistic picture is presented for private-plane activity.

MANY TECHNICAL IMPROVEMENTS MUST BE MADE

To rationalize this thought, however, we must realize that numerous technical improvements must be made before the average individual will be able to fly his own airplane. It is true that, once in the air, the cost per mile of airplane operation is extremely low; in fact, transcontinental trips have been made with single-engine light planes at an over-all fuel cost of less than $30. It is also true that, with mass production, there will be many planes which will be no more costly to purchase than a moderately priced automobile, but the old saying must not be forgotten, "It's not the original cost, it's the upkeep."

Reduced maintenance requirements, hangar facilities, airway traffic control, improved communication facilities, the location and frequency of airports or landing strips are only a few of the problems that will require considerable study and advancement beyond their present stages, before the average individual can derive any real economical transportation advantages by private-plane ownership.

Airway traffic control presents a real problem. As in the case of the automobile, before control could be established, suitable highways had to be built and policed, so aerial highways have had to be developed to control air traffic. The latter development has resulted from our knowledge of electronics which today provides a network of radio-range stations indicating to pilots flight paths as definitely defined as surface highways. This vast network of offices and communication circuits was charged with the responsibility of handling over 6,000,000 aircraft movements during the fiscal year 1942, which was more than four times the number handled during 1941. Estimates indicate that between 11,000,000 and 12,000,000 aircraft movements were handled in 1943. Considering the expansion that will unquestionably take place, the Civil Aeronautics Board believes plans should be made for at least 60,000,000 aircraft movements by 1950. Of this number, it is expected that nearly one third will be instrument-flight operation.

Unless our air-traffic-control procedures can be advanced to a stage where the time element for the handling of each movement is substantially reduced, controlling air traffic may prove to be the limiting factor in our future air transportation. For example, under present contact-flight-rule conditions, the average airport can accommodate only 1 aircraft or 1 landing per min, or an average of 60 per hr. This assumes of course that only one runway is available, which is the situation at the majority of fields. By extremely close co-ordination with the control tower, it is possible to increase this number to 75 per hr. It is a different situation under instrument-flight conditions, since, with the approach procedures normally used and taking into consideration the communication lags, it requires 10 to 15 minutes to handle an individual landing.

An improved type of approach has been developed which requires less maneuvering and permits a landing every 5 to 10 minutes. This is referred to as the "direct approach," but it is not the final answer in the handling of volume traffic.

As equipment becomes available, ultra-high-frequency radio ranges and glide-path equipment are being installed throughout the country and these, coupled with new electronic devices which are being developed as a result of the war, will undoubtedly permit the control of traffic during instrument conditions to approach the same efficiency as under contact conditions. Likewise, the capacity of airports will be increased with the use of multiple runways so that more than one landing and take-off may be made simultaneously. Where the pilot now uses valuable time on crowded radio channels to report over specified check points, undoubtedly, this reporting will be handled by automatic control in the future, which will permit instantaneous recognition of the aircraft position in the control office without the present undesirable communication lags.

Adequate ground facilities must be improved. Just as suitable roads for speed and safety had to be constructed before the automobile came into general use, likewise good landing and take-off facilities must become commonplace before civil aviation can reach its fullest development.

The idea of developing landing strips adjacent to public highways was first conceived by a military pilot in the first world war. These roadside landing and parking areas, at present considered vital for adequate air defenses, are destined for a large role in civil air commerce after the war. In this program is seen the beginning of a network of roadside landing facilities which eventually may blanket the United States and perhaps extend beyond these borders, knitting closely together by air all countries of North and South America. This program will not detract from or interfere with the nation's airport program, but instead should tend to intensify this program.

FUTURE AIR-MAIL POSSIBILITIES

World progress may be measured by improvement in communication facilities, which applies to the written word as well as to the spoken. The domestic air lines are handling millions of ton-miles of air mail, and each important letter or document speeded to its destination is a contributing factor to this progress. It is likely that eventually all first-class mail will be handled by air. Certainly mail which cannot be delivered to its destination by overnight surface transportation should eventually fly. The advantages of air-mail service to the businessman are well recognized.

Much progress has been made with air-mail pickup systems as a result of activity by private companies. In fact, one

Presented at a meeting of the North Texas Section of The American Society of Mechanical Engineers, Dallas, Texas, February 21, 1944.

organization in the eastern part of the United States operates an air-mail pickup system serving over 100 communities. This type of service, augmenting the future domestic air-transport routes, will enable every town and hamlet to be connected together not only among themselves but with the entire world by air-mail communication.

The Post Office Department has made great strides in fostering the development of air-mail routes throughout the United States. As a result of this development, air-mail payments to the air carriers have been substantially reduced, and yet income to the Post Office is on the increase. In 1931, the Post Office paid nearly $17,000,000 to domestic air carriers, during which period it received slightly over $6,000,000, a deficit of approximately $11,000,000. In 1942, it paid nearly $23,000,000 to air carriers, while the air-mail revenue was over $33,000,000. Thus, in 11 years, the air-mail section of the Post Office Department went from an $11,000,000 deficit to a profit of almost the same amount from air-mail operation. During the fiscal year of 1942, nearly 16,000,000 ton-miles of air mail were flown by the domestic air lines.

Five years ago our planes were scheduled 1 hr in the air for every 3 hr on the ground, or an average utilization of 8 hr per day. Today, this ratio has been reduced to 12 hr in the air for every 12 hr on the ground, and each plane operates approximately 1800 miles per day. With improved maintenance procedures and advanced types of equipment, our future planes should remain in the air 2 hr for every 1-hr period spent on the ground.

COST OF AIR TRANSPORTATION BEING REDUCED

Our engineers are engaged in the never-ending search for lower operating costs. As these costs are reduced, and as air transportation becomes more widely accepted, the industry will pass on to the public the effect in the form of reduced fares. The transition may be so gradual that it will be absorbed in everyday business routine in such a manner as to go unnoticed. For example, passenger fares have undergone a gradual reduction without fanfare from a high of 12 cents per mile in the beginning to today's average of 5 cents per mile.

We know these fares will be further reduced as more efficient types of equipment are made available for our use. They can be made no lower than sound economic business principles will justify. The public's mass acceptance of air transportation as passengers and as shippers will be the controlling factor.

The potentialities of air cargo are virtually unlimited. For example, marketing methods of today require picking fruit while it is green, transporting it over a period of days to the distributing center, having it ripen in heated rooms, after which it is sold to the public lacking the original taste placed there by Nature. Present methods may be substantially changed in the future, when fruit picked in the morning can be flown directly to the market and served on the table that same day. This method of handling will stimulate new markets, and even though a premium rate will have to be charged for transportation of this nature, the many small items of overhead saved otherwise will partially or completely compensate for additional transportation charges.

It is possible that wholesale methods may change radically for certain types of commodities. With air delivery of commodities from manufacturers' stocks becoming possible, industrial inventories may be greatly reduced.

But here again, we must not be misled by our enthusiasm. There are many commodities which are not susceptible of handling via air transportation except in cases of emergency. There is still much research to be done before planes can be utilized to their ultimate advantage in this field.

This is an especially pertinent field for the mechanical engineer. Methods of handling cargo on the ground, mechanized terminal facilities, perhaps precooling arrangements for perishable foods, methods of loading and unloading cargo, methods of securing cargo within the planes which will not only permit ready access but will eliminate any possibility of shifting, especially important in turbulent air, are only a few of the problems that are undergoing constant research, and which must be answered before air cargo is a routine part of our everyday existence.

THE PLANE OF TOMORROW

The air lines are frequently asked to describe the plane of tomorrow. The obvious answer is that there is no single "plane of tomorrow." Future air transportation will require a number of types of planes. There will be the cargo freight carrier, and planes will be designed as combination passenger-and-cargo units. Eventually, special types will be developed to handle short-haul feeder service which can be operated economically between stops less than 50 miles apart. Four-engine equipment scheduled on nonstop or one-stop high-speed transcontinental service will be regular equipment, and giant air liners will perform overseas service. Our transcontinental and intercontinental equipment will be operated at high altitudes above the turbulent air and storm areas. The cabins will be supercharged so that maximum passenger comfort will be provided.

Many problems must be solved in producing these planes of the future. Others are already in process of solution as a result of military-aircraft developments. Some may never be overcome since we know that no ideal unit has ever been constructed. For example, the electrical system offers a unique challenge to electrical and mechanical engineers. In the majority of cases, present practice is to supply low-voltage, high-amperage, direct current from storage batteries. The copper wire alone utilized represents a substantial portion of the entire weight of the system.

TECHNICAL DIFFICULTIES TO OVERCOME

The use of alternating current on board aircraft offers many advantages. In larger planes, it is desirable to have available higher voltages and a number of different voltages. With alternating current, these potentials may easily be produced by the use of transformers. However, the problem of generating alternating current presents difficulties. It would be desirable to drive an alternator direct from the present power plants, but a mechanical drive has not yet been devised that will permit the alternator to operate at constant speed while the horsepower of the engine is fluctuating due to atmospheric changes, changes in propeller settings, throttle control, etc. In lieu of such an arrangement, it is necessary to use auxiliary power plants in the form of small internal-combustion engines. In order to provide the necessary safety factor, duplicate systems must be installed. This requires more than one power plant and greatly increased weight. Further, when operating such plants at higher altitudes supercharging must be employed. This is but one of a multitude of items which offer a challenge to the engineer.

Another is the never-ending search for better horsepower-to-weight ratios in the power plant. This ratio is now approaching 1 to 1, which means that for 1 lb of weight the engine is able to produce 1 hp. Indeed, the power plant of the future may be other than an internal-combustion engine. Jet propulsion introduces many interesting possibilities, but here again, it is desirable that we proceed slowly and with a firm basis for this development.

Improved deicing equipment must be developed. The problem here is not that the weight of ice causes trouble, but when the ice builds up on the leading edge of the wing it distorts the airfoil and causes a reduction in lift.

We must have improved soundproofing in order to offer the maximum of passenger comfort. Better performance efficiency is necessary which will increase the block-to-block speed. This latter figure is the deciding factor in the time element of air

(Continued on page 320)

THE JOB AHEAD *for* MANAGEMENT

Brief Forecasts by Ten Leaders in the Management Field Presented at the 1943 A.S.M.E. Annual Meeting

THE job ahead for management was the topic of discussion at the Management Luncheon held on Nov. 30, 1943, under the auspices of the Management Division in connection with the 1943 Annual Meeting of The American Society of Mechanical Engineers.

James M. Talbot, chairman of the A.S.M.E. Management Division, vice-president S. S. White Dental Manufacturing Company, presided at the luncheon and introduced the speakers.

Mr. Talbot recalled that at the 1942 Management Luncheon, the Ten-Year Progress Report on Management was presented as a memorial to L. P. Alford, who had prepared previous ten-year reports. In planning the 1943 luncheon, he continued, it was decided to ask several persons to speak briefly on various phases of the job ahead for management in order to present a composite picture as seen through the eyes of several engineers. "A composite picture is usually a slightly blurred one," he warned, "and it is not surprising if the distant vista is somewhat hazy, but I am sure we shall get a glimpse of the hills and valleys that lie ahead."

The contributions of the several speakers, some of which were read by Mr. Talbot in the absence of the authors, follow.

Management's Job Goes on Forever

By LAWRENCE A. APPLEY[1]

MANAGEMENTS come and managements go but management's job goes on forever. It is always the same. The job of management is to be responsible for the type, direction, and amount of progress made regardless of the situation. In peace or in war, in depression or in prosperity, it is always management's responsibility to meet the challenge of the times, to plot the course, and to see that the desired results are accomplished.

In the dark days of the early 30's it was accepted by many that management had failed and that we would have to change our economic system to save ourselves. At the time of Pearl Harbor no living person openly prophesied that management could or would accomplish the tremendous conversion job from peacetime to wartime production that has been accomplished in the last two years. There are those who say that management will be unable to convert back to peacetime economy without our again experiencing a depression that will dwarf that of the 30's by comparison.

Regardless of what one thinks as to the capacity of management, the answer is that whatever we have in the way of a postwar economic world, it will be what management gives us. There are certain rules of the game that have always controlled the success or failure of management. The rules still hold and they always will.

The one greatest factor that determines success or failure is the way in which management deals with the human element. Economic history is a cycle of peaks and valleys which bear a direct relationship to the amount and type of consideration given by management to the employees whose services they buy and to the consuming public to whom they render service.

Management must plan carefully and adequately. It must then provide controls to see that the organizations involved accomplish the plans. Management must lead. The success or failure in meeting the challenge which faces us for the duration of the war and the challenge of a postwar economy depends upon the extent to which management accepts its responsibility for the lives of the people it influences.

[1] Deputy Chairman and Executive Director, War Manpower Commission, and Vice-President, Vick Chemical Company, Associate A.S.M.E.

Management's Job Is Multidimensional and Complex

By JOHN R. BANGS[2]

THE job ahead for management is multidimensional and complex. Broadly speaking it may be broken down under two major headings. The first of these is concerned with the immediate problem relating to the solution of a basic manpower shortage; the second is largely concerned with meeting the challenge of the postwar period.

In the past, management has thought largely in terms of manpower supply; the job for management now is more effective manpower utilization. Precious man-hours are still being lost through ineffective usage, through excessively high turnover, and through various restrictive practices.

A most valuable and often overlooked source of unused manpower exists right within the walls of our own factories. This labor potential, equivalent to many millions of man-hours, consists of men and women now on our pay rolls. Maximum utilization of these workers must be management's immediate objective. Maximum utilization is based upon better job instruction, the more intelligent use of proper methods, machinery, and equipment, and a real understanding of human relations.

Over two thousand years ago, the Chinese philosopher, Confucius, said: "In all things, success depends upon preparation and without such preparation, failure is almost certain."

In meeting the challenge of the postwar period, management must continue to concentrate on our Congress to get provision for adequate reserves in either the new revenue act or the amended renegotiations act. Such reserves are the key to reconversion of our plants to peacetime production. Similarly, management must prepare now for war-contract cancellation and the necessary inventory adjustments that go with the cessation of hostilities. Frozen inventories, such as happened in 1921, could spell disaster for postwar employment.

Management must formulate its postwar relationships with respect to its employees. Labor has well enunciated postwar plans of its own, and management's job is to make certain it has equally good or better plans.

Most important of all, looms management's job of postwar employment. Plans must be made *now* by the managements of individual companies throughout the land to achieve a level of production and consumption after the war estimated at from

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35 to 40 per cent above that of 1940. Only by doing so can it provide enough jobs to give employment to a group of people of from seven to eight millions higher than any previous normal period. These twin objectives of high-level production and high-level employment may be achieved in several ways:

First, by the utilization of all technological improvements and developments that can be profitably used.

Second, by the expansion of sales and production of each company through the development of new products or services, and the improvement of old products or services.

Third, by reducing the cost of production and distribution to stimulate demand, both foreign and domestic.

I wish to emphasize that when I speak of management I am referring to the management of the three million odd individual businesses and industrial establishments scattered throughout this country. I do not believe in management by agency—Government or otherwise. The future of America lies in the initiative and resourcefulness of its individual enterprises. If they manage well, the future is secure.

Know-How for Direction of Industry Is Needed

By WALLACE CLARK[3]

THE job ahead of management is to provide the know-how for the direction of industry in an area of rapid technical progress. To do this we must keep pace with the technical engineers, physicists, and other scientists. This will not be easy. During the present war their achievements have been so outstanding in research, development, and production that not only are there miraculous new products, but whole new industries, ready to be launched as soon as the war approaches its end.

The war not only has given these scientists an opportunity to show what they could do. It also has enabled management to apply its technics more deeply and in broadening fields until we have found ourselves in the laboratories of the scientists, working with them on their miracles.

In electronics, for example, as the physicist brings his idea out of the realm of pure research and through the various stages of development, the management engineer works beside him. He schedules experiments, prepares specifications, transfers information to the manufacturer, times the tooling up, the procurement of materials, the production of parts, and the final assembly. He co-ordinates all these steps, and, as a result, development and production move rapidly while the scientist proceeds with other research.

In the same way the management engineer has been working more closely and on a greater scale than ever before with all other branches of engineers. In ordnance plants, shipyards, and aircraft factories this collaboration has resulted in quantity, quality, and speed previously thought incredible.

The job ahead of management is to extend our thinking and to perfect our practical methods so that these can match the challenge of our brother engineers and scientists.

One Job Ahead—A More Equitable Basis for the Payment of Wages

By RALPH M. BARNES[4]

OF the many problems demanding attention from management today the payment of wages is one of the most important. Although it is true that general levels of wages may be determined by agencies of the govenment or through collective bargaining, the determination of the worth of a particular occupation or job in an organization is management's responsibility. Moreover, since a large percentage of factory work is paid for through the use of some form of wage incentive it is obvious that the determination of the standard time for the job and the wage-incentive plan to be used is of vital importance to management and to the worker. These three closely related functions of management—job evaluation, work measurement, and wage incentives—are particularly in need of clarification and standardization.

1 We need an acceptable national standard procedure or method of job evaluation with special standardized sections for each of the major industries. The "West Coast Aircraft Industries Job Evaluation and Wage Stabilization Manual" prepared jointly by the aircraft industries on the West Coast is a step in this direction.

2 Determining what constitutes a day's work is the main purpose of stop-watch time study. We need to improve this tool, particularly that phase of time study dealing with the rating of operator performance and the determination of allowances.

3 We need more complete and reliable information as to the type of incentive, the amount of incentive, and the method of wage payment for greatest benefits to workers and management. Management too often does not know how poorly its wage-incentive plan is functioning and how little it accomplishes.

Every activity in connection with the payment of wages needs reviewing and standardizing. This is a big job—one that management societies should support wholeheartedly and one that industry must of necessity underwrite.

I am fully aware that there are many other urgent jobs ahead for management but this one must be classified as of major importance.

Biomechanics—a Field for Management

By LILLIAN M. GILBRETH[5]

TWO very important developments in management had their first presentation before the A.S.M.E. at the Davenport meeting in April, 1943. One was biomechanics which had been defined as the science which deals with the forces which act on living cells or the living body. This science is taking its place along with industrial medicine and motion study in the industries. Through carefully set-up programs, the worker is conditioned for the job, and the experienced worker is helped to eliminate strain, to do his work more easily and with less fatigue. Job requirements, from the standpoint of operating, are being supplemented by data supplied by the biomechanics expert. The result is also being effectively used in a pioneer project which the Arma Corporation of Brooklyn is developing in co-operation with the United States Navy for rehabilitating service men in the hospitals for usefulness in industry.

The second project introduced in Iowa was the application of motion study to agriculture. Purdue University, under a grant from the general education board, has been giving courses in farm work simplification to men and women of agricultural extension divisions all over the country. This has developed into projects on many campuses which should make a great contribution toward solving the food problem.

This work is being supplemented by a modification of job instructor training (J.I.T.) adapted to agriculture by the American Society of Agricultural Engineers.

The contribution of T.W.I. to management increases in size and value. The grand total of those trained in the three branches, J.I.T., J.M.T., and J.R.T., will soon reach a million.

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[4] Professor of Industrial Engineering and Director of Personnel, University of Iowa, Iowa City, Iowa. Mem. A.S.M.E.

[5] President, Gilbreth, Inc., Montclair, N. J. Mem. A.S.M.E.

Among these are groups of librarians who will be a great asset to the management movement everywhere.

Quality Control a Useful Management Tool

BY C. S. GOTWALS[6]

MANAGEMENT has many jobs to perform in the future, not the least of which is the establishment of an adequate quality-control department. While this management tool has been used by a few industrial establishments for a number of years, its value has not been generally understood and therefore not adopted.

The quality-control department should provide prompt accurate information to the manufacturing division to keep the product within engineering standards. The proper application of control-chart procedure and statistical analyses is of invaluable aid to the producing departments and it is of vital importance that management recognize this fact and provide full support to such a program.

It has been said many times before and will bear repeating again, that quality must be built into the product. No amount of inspection or quality-control technique will in itself make the product any better. The value, however, is in getting accurate data to the manufacturing department so promptly that changes can be made immediately.

Management must recognize that a properly functioning quality-control department will insure better quality, yet decrease the amount of inspection; will decrease the amount of scrap material by keeping farther away from specification limits; will improve customer relations by more uniform product; and will provide a fair basis for determining product tolerances in regard to economy of manufacture.

Quality control is a "must" job ahead for management.

Reconversion Will Present Challenge

BY PAUL E. HOLDEN[7]

MANAGEMENT of American industry has been accustomed to facing challenges and, for the most part, meeting such challenges with courage and effectiveness. No more conclusive demonstration of that ability need be mentioned than the amazing acceleration and volume of production of war material during the past two years.

While the conversion of industry to war production has tested the ability and resourcefulness of management to an unprecedented degree, the reconversion to peacetime operation will present an even greater challenge. Many different factors will be involved and certainly the emphasis will be shifted.

This challenge will not be met by wishful thinking or by pure opportunism. Nothing short of the most thorough planning by the ablest of executives will provide an adequate solution. Current discussion and business literature is replete with the term postwar planning—simply another expression for long-range planning. However, it is not entirely evident that management is cognizant of the full implications of long-range planning.

The development of new products and the exploration of potential markets are but two phases. Long-range planning embraces every phase and activity of a business. It involves each division and department of a company. It includes such aspects as the revamping of policies, the redesigning of the organization structure, the remodeling of all personnel training, the refining of the procedures of control, the reshaping of the financial structure, the restudy of prices, costs, labor relations practices—all integrated into a specific plan and objective.

Therefore, the job ahead for management resolves itself into two parts: (1) Visualize the dimensions and ramifications of the problem; (2) develop a comprehensive and planned approach to the problem. The job is one which commands the most competent talent available in every company. These individuals should be relieved of all their existing duties and responsibilities and hence be free to devote their entire time to the problem. Management should translate into terms of over-all company operations the philosophy, principles, and techniques of planning which have been so highly developed and so effective in our production operations.

The need of a well-planned peacetime program for American industrial establishments may be more imminent than we realize. The stakes are perhaps higher than many of us realize.

Economic Freedom at Stake

BY DEXTER S. KIMBALL[8]

THE job ahead for management—and by management the writer means top-ranking or policy-making management—is obviously to restore industry to civilian production so far as necessary and to take up the slack of unemployment as the war comes to an end. Many forward-looking companies are already at work planning so far as is possible for postwar conditions.

However well-intentioned these efforts may be, their success will be, in no small degree, affected by the attitude of the federal government. We shall emerge from the war with the federal government owning outright a number of large plants and much industrial machinery and with what amounts to a mortgage on much more industrial equipment. Will these holdings be turned over to private enterprise or will the federal government take this occasion to extend its competition with private enterprise?

Many industrial plants have been converted to the production of war equipment vastly different from that for which they were designed originally. Will the owners of these plants be left with sufficient funds to reconvert to peacetime products, or will federal taxes, as it now seems probable, leave them stripped bare of assets necessary for this much-desired change?

These and similar questions must be answered before management can see its way into the future. And the much discussed four freedoms will be meaningless unless they are implemented by *economic freedom* or the *freedom of enterprise* that has made this country great. Without this we may very well win this war and lose the only freedom on which all others depend.

Management Must Improve Faulty Practices

BY HAROLD B. MAYNARD[9]

FROM the viewpoint of the methods engineer, management faces a twofold task if it is to secure to the fullest extent the benefits which the methods-engineering procedure can yield.

It must be recognized that many of the difficulties which have been encountered in the past by time and motion study and wage incentives have been caused by faulty administrative practices for which management must accept the blame. There has been altogether too little understanding of these tools of management by those whose administrative decisions can make or break the success of this work. Therefore, management's

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[7] Professor of Industrial Management, Graduate School of Business, Stanford University, Calif. Mem. A.S.M.E.

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[9] President, Methods Engineering Council, Pittsburgh, Pa.

first job ahead is to acquire a more practical understanding of what these procedures are—how they work and how they must be applied—than it has had as a group up to this time.

This is particularly necessary because the technicians in the methods-engineering field have been steadily developing their procedures. They have reached the point where they can devise methods of doing work which will increase the level of productivity of the individual worker to a point far beyond what it is at the present time, but their work must have the support of a well-informed management if it is to succeed.

The second job ahead for management is to arrive at a working agreement with labor so that methods-engineering work can go ahead with the full co-operation of all concerned. Too much of it now must be done under conditions which resemble the bickerings of two opposing lawyers arguing about technicalities of the law rather than the justice of the case. Labor must be led to realize that when it restricts production, opposes better methods, or insists upon the retention of old standards after a method has been changed, it is only harming its own best interests. The job of bringing about this realization is one of the most important which faces management.

Management in Government

By WM. H. KUSHNICK[10]

THE job ahead for management is much the same as it has been heretofore. There are some who will rightly say that the job is to win the war. There are others who will say, rightly also, that the job is to plan for the postwar period so as to maintain a prosperous economy. Still others will ask that a single phase of management activity be emphasized, such as methods improvement or better industrial relationships. All of which strengthens my conviction that the job ahead for management is comprehensive and is a continuing challenge to our capacity to economically organize and utilize the human and physical resources of our nation so as to increase the well being of our people.

Consequently, I can only suggest another area of emphasis as the job ahead for management. I would like to see the extensive indoctrination of scientific management principles and practices in the business of government. It has been reliably estimated that there are now about five million employees of our Federal, State, and Local Goverments, exclusive of those who are in the educational systems. That's a mighty industry and although it will probably diminish somewhat in numbers after the war, it will still be of sufficient size to warrant serious attention. I humbly suggest that the business of government can gain very measurably from adopting the engineering approach toward improving the quality and quantity of its service to the public. I make the suggestion seriously and regardless of which party is in control.

It is unfortunate that the public tends to accept poor organization structure, archaic system inflexible rules and procedure, costly red tape, inefficient operations, as indigenous in government. There has not therefore been the compelling force necessary to accelerate management improvement. Yet it is true that internally within the departments and agencies of the federal government, and also in state and local governments, capable staffs are devoting their efforts toward bringing better management into the conduct of governmental business.

This Society has provided the leaders in the science of management. It has provided the leadership in extending the application of scientific management in industry. It should provide leadership in accelerating the extension of those same successful principles, methods, and techniques to the administration of government. That can be a job ahead for management, and the Management Division.

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Summary

By HAROLD V. COES[11]

A PROPERLY functioning quality-control department will insure better quality, decrease the amount of inspection and scrap, improve customer relations, and provide a fair basis for determining the economic relationship between tolerances and manufacture.

Top management should have a better understanding of the uses and relationships of time and motion study and wage incentives. It should arrive at a working agreement with labor with regard to the uses of these tools for mutual benefits to both parties. A more practical understanding should be had of the utility of methods engineering.

Job valuation, work measurement, and wage incentives are particularly in need of clarification and standardization. Acceptable standards and the economic relationships between the standards and incentives are needed for maximum mutual benefit to both labor and management.

Management needs to watch closely the developments in biomechanics and the application of motion study and work simplification to agriculture.

Reconversion to peacetime operation will present a great challenge to management to visualize the dimensions and ramifications of the problems and to develop a comprehensive and planned approach to the solution of them. Top management, however, cannot see its way clearly into at least a part of the future until national policies with respect to government-owned plants, government-financed plants, funds for reconversion, taxation, the demobilization program, and the like are known.

Upon these policies, upon management's bold and sound solution of its reconversion problems, and upon its ability to utilize modern management techniques effectively depends the health, happiness, and livelihood of millions of men and women and the future of the free-enterprise system.

Aviation and the Future

(*Continued from page 316*)

transportation from one airport to another. As an example, the DC-3 cruises at 180 mph. However, due to the time lost in taxiing, climbing to the cruising altitude, and maneuvering for a landing, the block-to-block speed is reduced to approximately 152 mph. This is an especially important point when considering the use of air transportation on extremely short distances such as would be involved in what is referred to as feeder-line operation. If airports are not close to the city, the time required in reaching the airport, flying to the airport nearest the destination, and traveling from the airport to the destination is greater than if surface transportation had been used. The manufacturers and domestic air carriers are well aware of this situation, and before we can offer serious competition on this type of service, we must be in a position not only to compete with surface carriers from the standpoint of the time element but we must also come within the price range as well. The one redeeming feature in this situation is that traffic-flow studies indicate that the community of interest is not between two adjacent small cities, but instead is between the small cities and the nearest metropolitan area. The use of a skip-stop scheduling program will not only offer a high frequency of service between the larger cities, but will permit the smaller intermediate cities to be directly connected with the larger areas without resorting to a purely local schedule which stops at every station.

The aircraft industry rests its case with the engineering professions, knowing that the problems mentioned briefly and others which develop will find a solution.

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Modern TOOLS *of* SAFETY

By EDWARD A. CLARK

SAFETY DIRECTOR, FRANKFORD ARSENAL, PHILADELPHIA, PA.

IT is time that the safety or accident-prevention problem should be surveyed from a more modern perspective than the viewpoint from which it often is considered. The fields of industrial and chemical science have progressed so far and so fast during recent years that the correlation of safety has been prone to lag far behind.

In order to eliminate this lag, a thoroughly up-to-date safety program is essential. Several fundamental factors need to be recognized. Many of these are elementary requirements but they are apt to be forgotten or improperly evaluated; others cover a new progressive concept of responsibility.

First, let us affirm that all accidents can be prevented. Not the 90 to 98 per cent usually claimed, but 100 per cent. To clarify why some accidents happen, let us quote a definition of an accident that the author gave to a New York insurance group five years ago: "An accident is an event which occurs as the logical and inevitable pursuit of natural law, but against which we have failed to protect ourselves, due to a lack of knowledge, authority, interest, concentration, or discipline. The element of surprise is the characteristic mark of an accident, since if all laws and causes were completely examined and understood we would know in advance their results and be free to take the obvious precautionary steps."

This does not mean that we will find it feasible from an administrative standpoint to stop all accidents; other factors are involved. If we are going to get out production on time, with restricted manpower, old equipment, and at a certain figure, reasonable allowances and compromises must be made. It is obviously not good management to spend ten dollars to save one dollar, or to miss the woods for the trees.

However, safety men should grow out of the habit of calling any accident "unavoidable" or an "act of God." This is sloppy, evasive, blasphemous, incompetent thinking used as an alibi to cover inadequacy in meeting a problem. It is a nice "out" for legal contracts and disinterested supervisors but should have no acceptance by engineers. The author has presented a formula which indicates the balance between the investment put into safety and the results obtained. This formula can be plotted as a graph which will clearly indicate what investment must be made to attain the exact results desired. Such information can be highly important to management in the determination of policy.

ORGANIZING A SAFETY PROGRAM

Now, what about the framework for a modern safety program? First, of course, an organization is needed. Its structure will vary with the industry involved, but qualified engineering personnel will be needed; personnel which can be effective, diplomatic, and alert to changing processes and trends. Today's progressive safety engineer should be equally at home in formal gatherings or in the interior of a machine. Any safety engineer worthy of his title should be able to save the management at least ten times his salary. The department should be headed by a safety director with centralized authority and responsibility. It should have the continuous backing and interest of the management. To emphasize, not "backing or interest" but "backing and interest."

To function effectively, the safety program needs the active participation of employees, on a continuous basis. How to get and keep this participation active is a matter involving morale, education, incentive, and ingenuity; but active it must be. Without the backing and interest of management, or without the participation of employees, a safety department full of Einsteins and Eddingtons would be worthless. Competitions, where used, should be alive, honest, and varied. They should not be negative or personal. They should not encourage shops to conceal accidents for the sake of the record. Periodic shop safety meetings are among the most valuable items in this framework. Safety suggestions should be encouraged among workers, as such suggestions not only have saved manpower, production costs, and have avoided injuries, but indirectly have increased efficiency, morale, and production. Management should obviously not participate in a safety-award contest, nor should members of the safety staff, whose function it is to solve safety problems.

SOME SAFETY "TOOLS"

This, then, is the framework; now what are some of the tools? The first tool is the provision of "rules and regulations" to guide supervisors. We all have seen dozens of booklets and pamphlets on safety, most of which have had the weakness of being too general, too lacking in specific instructions. It is time now for us to be less vague. We should give standards, limits, tolerances, and so forth. We need to show how much, where, how, and under what conditions. We must stop using platitudes. We must give definite practical rules easily understood by supervisors.

The second tool is that of "inspections" with subsequent "recommendations." These should be done by men not only in authority but who know what they are talking about. They should be able and willing to show how to effect the improvement without interfering with production. A good safety engineer or inspector should be welcomed by all shopmen and not considered "old-man nuisance" or a critic. He should keep up to date with the ever-increasing flow of new materials and processes.

Current inspections and recommendations should be correlated with rules and standard practices previously issued. The recommendations should be practical and thought through, in order to include all possible effects on production and personnel relationships. For instance, it should not be recommended that a certain type of small safety device be attached to equipment if this is going to require heavy structural changes. There will be an alternative solution, since there is always more than one answer. A shop should not be asked to stop a certain practice, such as overloading the warehouse, unless help is given in finding another space to move into. We need not compromise with safety, but we can compromise with the old ingrained ways of doing things. Anybody can make safety recommendations; it is not the mere number of them that produces results, it is the constructive helpful thought back of them that counts and that pays long-term dividends.

The third tool is that of "machine guarding," one of the oldest and first steps to be taken after foremen got tired of picking up dismembered parts of bodies. But let us add this thought: No guard should curtail production or interfere with the efficient running of the shop. If it does, the guard should be redesigned to fit the particular need. A good guard should speed up safe production. We know a lot more these days about machine design and production methods than formerly, and we need not accept the belief that to add a guard to a machine is to suffer a necessary investment evil in order to protect ignorant employees. It is good practice to have the safety department approve all guarding of new machinery before it is put

"on the line." But it is an error to think that because everything is beautifully guarded, we have discharged our responsibility. Approximately 85 per cent of all accidents are due to other causes than physical conditions such as inadequate machine guarding. A safety-minded experienced worker in a shop without any guards is preferable to a "jitterbug" or a "Dagwood" in a completely guarded shop.

The next tool is that of "protective clothing and equipment." This includes the usual list covering items with which the safety engineer is familiar. There is a continuous improvement in designs and models being offered the public. We need not accept something our grandpappy liked. The important thing to stress here is that this tool is secondary to a first-class job on mechanical-handling devices and structural design. For instance, if the ventilating problem in connection with toxic materials has been adequately solved at the source, we do not need respirators. Assuming then that the fundamental engineering problem has not yet been completely solved at the source, the next step is either to analyze and test the merits of the product firsthand or to accept the recommendations of competent authorities. There should be no hesitancy in changing and improving designs when found necessary. Hardly anything has ever been made which, if made over, some improvements would not be forthcoming.

As to clothing, it may be necessary to make special designs, particularly for women, and for certain exposures, as has been done in many cases. There is no need to be hampered by old styles or materials. There is nothing difficult about the problem of proper protective clothing, as like other safety problems it is simply a matter of engineering logic, common sense, alertness, and the refusal to recognize the word, "impossible."

The next tool is that of "training and education." Thank goodness, we are past the age of putting a new, inexperienced man on a machine and calling him a "dumb cluck" the first time he makes a mistake or loses a finger. We should take advantage of the recent advances in applied psychology now that the professors are no longer hiding behind their beards. We must have a strong working knowledge of personnel, morale, industrial relations, and educational methods. We must, morever, put that knowledge to work to get results. Furthermore, this program should be flexible enough to include the so-called physically handicapped. When properly trained and assigned, these workers are as safe as others. This program should especially include women. They are filling a great need in industry. They are a great reservoir of help at this time and can be an asset if handled with understanding. It can be proved that they are just as safe in the shop as are men.

Bulletin boards and posters in connection with this tool are valuable only if properly used; otherwise they are a liability. They should be kept neat, modern, and interesting. Only material that pertains to the work in the area should be used. A negative or a cheap approach should never be applied.

The next tool is closely allied with the last. It is that of "first-aid facilities and general health." In the main this should be delegated to qualified professional men and women. However, two details merit notice:

1 The safety department should get a report of every new first-aid case treated and select those which warrant investigation by its staff. As soon as a first-aid patient reports for treatment, it should be a signal that the safety precautions have broken down somewhere, or have been incomplete. The business of safety men is to see that the physician has practically no business. He is the one man, in addition to the fire department, whom we all love to see idle. The less they have to do, the better our production and economy.

2 Industrial hygiene and occupational health are, however, more matters of safety precautionary measures than first-aid treatment, and the safety department should be completely familiar with the entire range of exposures, and the correct methods of safeguarding personnel. This field is increasing yearly and warrants close study and control by qualified safety engineers with specialized knowledge of exposures. Activities should be correlated with any periodic physical checkup, "allergy," and mechanical design.

FIRE-FIGHTING SYSTEM A MAJOR PROTECTIVE MEASURE

Now that we have mentioned the fire department, it is a good time to recognize that proper fire-fighting means constitutes an essential protective tool. Regardless of whether we have our own service or use outside facilities, we must be assured that this service is dependable, efficient, and quick. But far more important than this is the distribution, maintenance, and use of the emergency, first-aid, fire-fighting equipment. This equipment is not for the fire department, which does not need it; they bring their own. If employees are properly trained in the way to use such emergency equipment, the fire department will not have anything to do and can go back to its maintenance and educational duties; and that is fine for all of us.

Nearly all the bad fires we have had in this country are due to failure to use this equipment intelligently and on time. None of us likes fires, but not enough of us stop them before they get out of control. There are some fine equipment and materials on the market today for fighting all types of fires. We should train our men in their use during the first few seconds when they are most needed. Fire prevention is, of course, a function of safety and, if properly carried out, should precede "fire fighting." This prevention is the work of the safety engineer, while the fighting is the work of the fire department.

SAFETY STATIONS AND REPORTS

The last tool to be covered here is the one of "statistics and reports." These are necessary to indicate where the accidents are happening, why, and how. They provide valuable graphs and charts. They show where some of the "bugs" are in the safety program and its execution. They give a hint of what we can do about it. They let us compare our record with the rest of the country. We should not be satisfied with our record if it is not less than one half of the national average for any particular type of activity.

Accidents should be reported on standardized forms by qualified inspectors and engineers who are diplomatic, thorough, alert, progressive, and technically trained. It should be recognized that every accident has a cause and that none is "unavoidable." The obsolete word "carelessness" should not be permitted on reports any more than the word "impossible."

A concise summary based on these statistics and analyses, with definite recommendations on how to improve the record, should be produced by the safety department. Management can then decide whether it wants to make the investment indicated in order to get the results promised. This ties in with the earlier statement on the necessity for the interest and backing of management, and the formula on intake and output.

CONCLUSION

There are other tools, but these are some of the more fundamental ones. The fields in which these tools are used cover the entire range of industrial activity. Special attention should be given to such fields as chemicals (especially solvents), explosives, pressure vessels, elevators and hoists, welding operations, electrical hazards, warehousing, construction activities, shop tools and equipment, and waste disposal. Even "housekeeping" includes such subdivisions as illumination, ventilation, sanitation, floor maintenance, loading, etc. All of these, and many other fields, are just as important as machine-guarding and can be solved as efficiently and progressively within the framework mentioned earlier.

The modern tools available for accident-prevention work are both varied and powerful. In the hands of men of practical vision, they can be of untold value to management in the conservation of manpower and the efficiency of production.

The Unwritten

LAWS *of* ENGINEERING

Part 1—What the Beginner Needs to Learn at Once

By W. J. King

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SOME years ago the author became very much impressed with the fact, which can be observed in any engineering organization, that the chief obstacles to the success of individual engineers or of the group comprising a unit were of a personal and administrative rather than a technical nature. It was apparent that both the author and his associates were getting into much more trouble by violating the unwritten laws of professional conduct than by committing technical sins against the well-documented laws of science. Since the former appeared to be indeed unwritten at that time, as regards any adequate and convenient text, the following "laws" were originally formulated and collected into a sort of scrapbook, to provide a set of "house rules," or a professional code, for a design-engineering section of a large manufacturing organization. Although they are admittedly fragmentary and incomplete, they are offered here for whatever they may be worth to younger men just starting their careers, and to older men who know these things perfectly well but who all too often fail to apply them in practice.

Just a few points should be emphasized: None of these "laws" is theoretical or imaginary, and however obvious and trite they may appear, their repeated violation is responsible for much of the frustration and embarrassment to which engineers everywhere are liable. In fact this paper is primarily a record, derived from direct observation over a period of seventeen years, of the experience of four engineering departments, three of them newly organized and struggling to establish themselves by the trial-and-error method. It has, however, been supplemented and confirmed by the experience of others as gathered from numerous discussions, lectures, and the literature, so that it most emphatically does not reflect the unique experience or characteristics of any one organization.

Furthermore, many of these rules are generalizations to which exceptions will occur in special circumstances. There is no thought of urging a slavish adherence to rules and red tape, for there is no substitute for judgment, and at times vigorous individual initiative is needed to cut through formalities in an emergency. But in many respects these laws are like the basic laws of society; they cannot be violated too often with impunity, notwithstanding striking exceptions in individual cases.

IN RELATION TO HIS WORK

However menial and trivial your early assignments may appear give them your best efforts. Many young engineers feel that the minor chores of a technical project are beneath their dignity and unworthy of their college training. They expect to prove their true worth in some major enterprise. Actually, the spirit and effectiveness with which you tackle your first humble tasks will very likely be carefully watched and may affect your entire career.

Occasionally a man will worry unduly about where his job is going to get him—whether it is sufficiently strategic or significant. Of course these are pertinent considerations and you would do well to take some stock of them, but by and large it is fundamentally true that if you take care of your present job well, the future will take care of itself. This is particularly so in the case of a large corporation, where executives are constantly searching for competent men to move up into more responsible positions. Success depends so largely upon personality, native ability, and vigorous, intelligent prosecution of any job that it is no exaggeration to say that your ultimate chances are much better if you do a good job on some minor detail than if you do a mediocre job as section head. Futhermore, it is also true that if you do not first make a good showing on your present job you are not likely to be given the opportunity of trying something else more to your liking.

There is always a premium upon the ability to get things done. This is a quality which may be achieved by various means under different circumstances. Specific aspects will be elaborated in some of the succeeding items. It can probably be reduced, however, to a combination of three basic characteristics, as follows:

(*a*) Energy which is expressed in initiative to start things and aggressiveness to keep them moving briskly.

(*b*) Resourcefulness or ingenuity, i.e., the faculty for finding ways to accomplish the desired result, and

(*c*) Persistence (tenacity), which is the disposition to persevere in spite of difficulties, discouragement, or indifference.

This last quality is sometimes lacking in the make-up of brilliant engineers, to such an extent that their effectiveness is greatly reduced. Such dilettantes are known as "good starters but poor finishers." Or else it will be said of a man: "You can't take him too seriously; he'll be all steamed up over an idea today but tomorrow he will have dropped it and started chasing some other rainbow." Bear in mind, therefore, that it may be worth while finishing a job, if it has any merit, just for the sake of finishing it.

In carrying out a project do not wait for foremen, vendors, and others to deliver the goods; go after them and keep everlastingly after them. This is one of the first things a new man has to learn in entering a manufacturing organization. Many novices assume that it is sufficient to place the order and sit back and wait until the goods are delivered. The fact is that most jobs move in direct proportion to the amount of follow-up and *expediting* that is applied to them. Expediting means planning, investigating, promoting, and facilitating every step in the process. Cultivate the habit of looking immediately for some way around each obstacle encountered, some other recourse or expedient to keep the job rolling without losing momentum. There are ten-to-one differences between individuals in respect to what it takes to stop their drive when they set out to get something done.

Note: This is the first of three installments dealing with various phases of the "human side of engineering."

On the other hand, the matter is occasionally overdone by overzealous individuals who make themselves obnoxious and antagonize everyone by their offensive browbeating tactics. Be careful about demanding action from another department. Too much insistence and agitation may result in more damage to a man's personal interests than could ever result from the miscarriage of the technical point involved.

Confirm your instructions and the other fellow's commitments in writing. Do not assume that the job will be done or the bargain kept just because the other fellow agreed to do it. Many people have poor memories, others are too busy, and almost everyone will take the matter a great deal more seriously if he sees it in writing. Of course there are exceptions, but at times it pays to mark a third party for a copy of the memo, as a witness.

When sent out on any complaint or other assignment stick with it and see it through to a successful finish. All too often a young engineer from the home office will leave a job half done or poorly done in order to catch a train or keep some other engagement. Wire the boss that you've got to stay over to clean up the job. Neither he nor the customer will like it if another man has to be sent out later to finish it up.

Avoid the very appearance of vacillation. One of the gravest indictments of an engineer is to say: "His opinion at any time depends merely upon the last man with whom he has talked." Refrain from stating an opinion or promoting an undertaking until you have had a reasonable opportunity to obtain and study the facts. Thereafter see it through if at all possible, unless fresh evidence makes it folly to persist. Obviously the extremes of bullheadedness and dogmatism should be avoided, but remember that reversed decisions will be held against you.

Don't be timid—speak up—express yourself and promote your ideas. Every young man should read Emerson's essay on "Self Reliance." Too many new men seem to think that their job is simply to do what they're told to do, along the lines laid down by the boss. Of course there are times when it is very wise and prudent to keep your mouth shut, but, as a rule, it pays to express your point of view whenever you can contribute something. The quiet mousey individual who says nothing is usually credited with having nothing to say.

It frequently happens in any sort of undertaking that nobody is sure of just how the matter ought to be handled; it's a question of selecting some kind of program with a reasonable chance of success. This is commonly to be observed in engineering-office conferences. The first man to speak up with a definite and plausible proposal has better than an even chance of carrying the floor, provided only that the scheme is definite and plausible. (The "best" scheme usually cannot be recognized as such in advance.) It also happens that the man who talks most knowingly and confidently about the matter will very often end up with the assignment to carry out the project. If you do not want the job, keep your mouth shut and you'll be overlooked, but you'll also be overlooked when it comes time to assign larger responsibilities.

Before asking for approval of any major action, have a definite plan and program worked out to support it. Executives very generally and very properly will refuse to approve any proposed undertaking that is not well planned and thought through as regards the practical details of its execution. Quite often a young man will propose a project without having worked out the means of accomplishing it, or weighing the actual advantages against the difficulties and costs. This is the difference between a "well-considered" and a "half-baked" scheme.

Strive for conciseness and clarity in oral or written reports. If there is one bane of an executive's existence, it is the man who takes a half hour of rambling discourse to tell him what could be said in one sentence of twenty words. There is a curious and widespread tendency among engineers to surround the answer to a simple question with so many preliminaries and commentaries that the answer itself can hardly be discerned. It is so difficult to get a direct answer out of some men that their usefulness is thereby greatly diminished. The tendency is to explain the answer before answering the question. To be sure, very few questions admit of simple answers without qualifications, but the important thing is to state the crux of the matter as succinctly as possible first. On the other hand, there are times when it is very important to add the pertinent background or other relevant facts to illuminate a simple statement. The trick is to convey the maximum of significant information in the minimum time, a valuable asset to any man.

An excellent guide in this respect may be found in the standard practice of newspapers in printing the news. The headlines give 90 per cent of the basic facts. If you have the time and the interest to read further, the first paragraph will give you most of the important particulars. Succeeding paragraphs simply give details of progressively diminishing significance. To fit an article into available space, the editor simply lops off paragraphs from the rear end, knowing that relatively little of importance will be lost. You can hardly do better than to adopt this method in your own reports, presenting your facts in the order of importance, as if you might be cut off any minute.

Be extremely careful of the accuracy of your statements. This seems almost trite, and yet many engineers lose the confidence of their superiors and associates by habitually guessing when they do not know the answer to a direct question. It is certainly important to be able to answer questions concerning your responsibilities, but a wrong answer is worse than no answer. If you do not know, say so, but also say, "I'll find out right away." If you are not certain, indicate the exact degree of certainty or approximation upon which your answer is based. A reputation for dependability and reliability can be one of your most valuable assets.

This applies, of course, to written matter, calculations, etc., as well as to oral reports. It is definitely bad business to submit a report to the boss for approval without first carefully checking it yourself, and yet formal reports are sometimes turned in full of glaring errors and omissions.

IN RELATION TO THE BOSS

Every executive must know what's going on in his bailiwick. This principle is so elementary and fundamental as to be axiomatic. It follows from the very obvious fact that a man cannot possibly manage his business successfully unless he knows what's going on in it. It applies to minor executives and other individuals charged with specific responsibilities as well as to department heads. No one in his right mind will deny the soundness of the principle and yet it is very commonly violated or overlooked. It is cited here because several of the rules which follow are concerned with specific violations of this cardinal requirement.

Do not overlook the fact that you're working for your boss. This sounds simple enough, but some engineers never get it. By all means, you're working for society, the company, the department, your family, and yourself, but primarily you should be working for and through your boss. And your boss is your immediate superior, to whom you report directly. As a rule, you can serve all other ends to best advantage by working for him, assuming that he's approximately the man he ought to be. It is not uncommon for young engineers, in their impatient zeal to get things done, to ignore the boss, or attempt to go over or around him. Sometimes they move a little faster that way, for a while, but sooner or later they find that such tactics cannot be tolerated in a large organization. Generally speak-

ing, you cannot get by the boss; he determines your rating and he rates you on your ability to co-operate, among other things. Besides, most of us get more satisfaction out of our jobs when we're able to give the boss our personal loyalty, with the feeling that we're helping him to get the main job done.

Be as particular as you can in the selection of your boss. In its effect upon your engineering career, this is second in importance only to the selection of proper parents. In most engineering organizations the influence of the senior engineer, or even the section head, is a major factor in molding the professional character of younger engineers. Long before the days of universities and textbooks, master craftsmen in all the arts absorbed their skills by apprenticeship to master craftsmen. It is very much as in the game of golf; a beginner who constantly plays in company with "dubs" is very apt to remain a "dub" himself, no matter how faithfully he studies the rules, whereas even a few rounds with a "pro" will usually improve a novice's game.

But, of course, it is not always possible to choose your boss advisedly. What if he turns out to be somewhat less than half the man he ought to be? There are only two proper alternatives open to you; (*a*) accept him as the representative of a higher authority and execute his policies and directives as effectively as possible, or (*b*) transfer to some other outfit at the first opportunity. A great deal of mischief can be done to the interests of all concerned (including the company) if some other alternative is elected, particularly in the case of younger men. Consider the damage to the efficiency of a military unit when the privates, disliking the leader, ignore or modify orders to suit their individual notions! To be sure, a business organization is not a military machine, but it is not a mob, either.

One of the first things you owe your boss is to keep him informed of all significant developments. This is a corollary of the preceding rules: An executive must know what's going on. The main question is: How much must he know—how many of the details? This is always a difficult matter for the new man to get straight. Many novices hesitate to bother the boss with too many reports, and it is certainly true that it can be overdone in this direction, but in by far the majority of cases the executive's problem is to extract enough information to keep adequately posted. For every time he has to say, "Don't bother me with so many details," there will be three times he will say, "Why doesn't someone tell me these things?" Bear in mind that he is constantly called upon to account for, defend, and explain your activities to the "higher-ups," as well as to co-ordinate these activities into a larger plan. In a nutshell, the rule is therefore to give him promptly all the information he needs for these two purposes.

Whatever the boss wants done takes top priority. You may think you have more important things to do first, but unless you obtain permission it is usually unwise to put any other project ahead of a specific assignment from your own boss. As a rule, he has good reasons for wanting his job done *now*, and it is apt to have a great deal more bearing upon your rating than less conspicuous projects which may appear more urgent.

Also, make a note of this: If you are instructed to do something and you subsequently decide it isn't worth doing (in view of new data or events) do not just let it die, but inform the boss of your intentions and reasons. Neglect of this point has caused trouble on more than one occasion.

Do not be too anxious to follow the boss's lead. This is the other side of the matter covered by the preceding rule. An undue subservience or deference to the department head's wishes is fairly common among young engineers. A man with this kind of psychology may:

1 Plague the boss incessantly for minute directions and approvals.

2 Surrender all initiative and depend upon the boss to do all of his basic thinking for him.

3 Persist in carrying through a design or a program even after new evidence has proved the original plan to be wrong.

This is where an engineering organization differs from an army. In general, the program laid down by the department or section head is tentative, rather than sacred, and is intended to serve only until a better program is proposed and approved.

This rule therefore is to tell your boss what you have done, at reasonable intervals, and ask his approval of any well-considered and properly planned deviations or new projects that you may have conceived.

REGARDING RELATIONS WITH ASSOCIATES AND OUTSIDERS

Never invade the domain of any other division without the knowledge and consent of the executive in charge. This is a very common offense, which causes no end of trouble. Exceptions will occur in respect to minor details, but the rule applies particularly to:

1 The employment of a subordinate. Never offer a man a job, or broach the matter at all, without first securing the permission of his boss. There may be excellent reasons why the man should not be disturbed.

2 Engaging the time or committing the services of a subordinate for some particular project or trip. How would you feel, after promising in a formal meeting to assign one of your men to an urgent project, to discover that some other executive had had the gall to send him on an out-of-town trip without attempting to notify you? Yet it has been done!

3 Dealings with customers or outsiders, with particular reference to making promises or commitments involving another division. In this connection bear in mind especially that, when you are in the "field" or the "districts," you are in the premises of the district manager or local office, and that all transactions must be with the manager's permission just as if you were in his home.

4 Performing any function assigned to another division or individual. Violations of this law often cause bitter resentments and untold mischief. The law itself is based upon three underlying principles:

(*a*) Most people strongly dislike having anyone "muscle" into their territory, undermining their job by appropriating their functions.

(*b*) Such interference breeds confusion and mistakes. The man in charge of the job usually knows much more about it than you do, and, even when you think you know enough about it, the chances are better than even that you'll overlook some important factor.

(*c*) Nine times out of ten when you're performing the other fellow's function you're neglecting you own. It is rarely that any engineer or executive is so caught up on his own responsibilities that he can afford to take on those of his colleagues.

There is a significant commentary on this last principle which should also be observed: In general you will get no credit or thanks for doing the other fellow's job for him at the expense of your own. But it frequently happens that, if you can put your own house in order first, an understanding of and an active interest in the affairs of other divisions will lead to promotion to a position of greater responsibility. Many a man has been moved up primarily because of a demonstrated capacity for taking care of other people's business as well as his own.

In all transactions be careful to "deal-in" everyone who has a right to be in. It is extremely easy, in a large corporation, to overlook the interests of some division or individual who does not happen to be represented, or in mind, when a significant step

is taken. Very often the result is that the step has to be retracted or else considerable damage is done. Even when it does no apparent harm, most people do not like to be left out when they have a stake in the matter, and the effect upon morale may be serious.

Of course there will be times when you cannot wait to stand on ceremony and you'll have to go ahead and "damn the torpedoes." But you cannot do it with impunity too often.

Note particularly that in this and the preceding item the chief offense lies in the invasion of the other man's territory without his knowledge and consent. You may find it expedient on occasions to do the other man's job for him, in order to get your own work done, but you should first give him a fair chance to deliver the goods or else agree to have you take over. If you must offend in this respect, at least you should realize that you are being offensive.

Be careful about whom you mark for copies of letters, memos, etc., when the interests of other departments are involved. A lot of mischief has been caused by young men broadcasting memoranda containing damaging or embarrassing statements. Of course it is sometimes difficult for a novice to recognize the "dynamite" in such a document but, in general, it is apt to cause trouble if it steps too heavily upon someone's toes or reveals a serious shortcoming on anybody's part. If it has wide distribution or if it concerns manufacturing or customer difficulties, you'd better get the boss to approve it before it goes out unless you're very sure of your ground.

Promises, schedules, and estimates are necessary and important instruments in a well-ordered business. Many engineers fail to realize this, or habitually try to dodge the irksome responsibility for making commitments. You *must* make promises based upon your own estimates for the part of the job for which you are responsible, together with estimates obtained from contributing departments for their parts. No one should be allowed to avoid the issue by the old formula, "I can't give a promise because it depends upon so many uncertain factors." Consider the "uncertain factors" confronting a department head who must make up a budget for an entire engineering department for a year in advance! Even the most uncertain case can be narrowed down by first asking, "Will it be done in a matter of a few hours or a few months—a few days or a few weeks?" It usually turns out that it cannot be done in less than three weeks and surely will not require more than five, in which case you'd better say four weeks. This allows one week for contingencies and sets you a reasonable bogie under the comfortable figure of five weeks. Both extremes are bad; a good engineer will set schedules which he can meet by energetic effort at a pace commensurate with the significance of the job.

As a corollary of the foregoing, you have a right to insist upon having estimates from responsible representatives of other departments. But in accepting promises, or statements of facts, it is frequently important to make sure that you are dealing with a properly qualified representative of the other section. Also bear in mind that when you ignore or discount another man's promises you impugn his responsibility and incur the extra liability yourself. Of course this is sometimes necessary, but be sure that you do it advisedly. Ideally, another man's promises should be negotiable instruments, like his personal check, in compiling estimates.

When you are dissatisfied with the services of another section, make your complaint to the individual most directly responsible for the function involved. Complaints made to a man's superiors, over his head, engender strong resentments and should be resorted to only when direct appeal fails. In many cases such complaints are made without giving the man a fair chance to correct the grievance, or even before he is aware of any dissatisfaction.

This applies particularly to individuals with whom you are accustomed to deal directly or at close range, or in cases where you know the man to whom the function has been assigned. It is more formal and in some instances possibly more correct to file a complaint with the head of a section or department, and it will no doubt tend to secure prompt results. But there are more than a few individuals who would never forgive you for complaining to their boss without giving them a fair chance to take care of the matter.

Next to a direct complaint to the top, it is sometimes almost as serious an offense to mark a man's boss for a copy of a letter containing a complaint or an implied criticism. Of course the occasion may justify such criticism; just be sure you know what you're doing.

In dealing with customers and outsiders remember that you represent the company, ostensibly with full responsibility and authority. You may be only a few months out of college but most outsiders will regard you as a legal, financial, and technical agent of your company in all transactions, so be careful of your commitments.

(*To be continued*)

High-Speed Milling of Steel With Carbides

(*Continued from page 304*)

3 Not to tackle difficult jobs until sufficient experience has been gained on the first simple jobs.

4 To use a fly cutter, that is, a single-toothed cutter which can easily be altered and reground to suit any particular job, when establishing cutter specifications for a specific and relatively complicated job.

The results claimed for such a method of establishing a carbide-milling program include:

1 It permits the individual machine operator gradually to become accustomed to working at greatly increased speeds and also gives him sufficient time to get the "feel" of high-production cutters.

2 The method is claimed to provide a time interval in which the grinding-room personnel can acquire the proper technique for grinding carbides. Experience has demonstrated that machining time will decrease to anywhere from 50 to 20 per cent of the cutting time when carbide milling cutters are installed if they are used correctly. Although the life of a carbide cutter is greater than that of a comparable high-speed-steel cutter in terms of pieces per grind, the rate of production with carbides is so much faster that more cutters will have to be ground in a day's time.

3 It is said to be possible for carbide engineers to estimate accurately the capacities of the individual milling machines and make any changes in fixture design that are indicated thereby. For example, it may be found expedient to install flywheels on spindles as well as some method to keep the chips clear of the cutter. A flywheel may be needed to smooth out the cutting action by overcoming the effect of backlash in the spindle and gears. An air blast or a heavy stream of coolant may be used to keep the increased amount of chips clear of the cutter and thus help prevent rapid tooth breakdown.

4 The simplicity of grinding and adjusting the fly cutter, when used to establish multitooth-cutter specifications, is said to enable the engineer to obtain more quickly answers to questions concerning the correct rakes, tip thickness, grade of carbide, chip load per tooth, and optimum speeds for any one particular job.

BETTER MANAGEMENT IN GOVERNMENT

By RALPH E. FREEMAN

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THE problem of bureaucracy falls into two parts, (1) the multiplication of bureaus resulting from the extension of government functions, and (2) the increase in the size and complexity of the individual agencies created to administer the functions.

The questions that arise in considering the first phase of the problem are not primarily administrative in character. They concern the economic and technological changes that have created a pressure for government intervention and the changes in social and political thinking which this pressure has helped to produce. Decisions in this field are squarely up to the public acting through Congress. If the public urges Congress to provide old-age pensions or unemployment insurance, bureaus must be set up staffed by people hired by the government and financed by the taxpayers.

The second part of the problem—how to perform a particular function using a minimum of personnel, time, equipment, and materials—can be solved only through good management. This is the subject of a book[2] by Mr. Juran, Assistant Administrator of the Office of Lend-Lease. In a lively style, he describes the working of the federal bureaucracy and presents the outlines of a program for improvement.

MALADIES THAT CAUSE GROWTH

The book begins with a brief description of the process of growth in government agencies and then discusses the "principal maladies that cause growth." Duplication is the common cold of the bureaucratic world and is attributable mainly to the tendency of all human institutions to strive for self-sufficiency.

Another type of disease is red tape which is really a family of maladies including delay, pigeonholing, indecision, and other phenomena contributing to inaction. Most of these ills may be traced to a meticulous obedience to rules and regulations—an attitude that arises out of a determination to avoid error at all costs. This zealousness for job accuracy, common to all government employees, is imposed upon bureaucrats by the "goldfish bowl" situation in which they find themselves and by the fact that if they take an unauthorized short cut, they are not rewarded for any economies achieved.

The author believes that the difficulty of providing incentives is the greatest of all obstacles in the way of applying scientific management in the bureaucracy. But he believes it possible to overcome this obstacle. Even financial incentives can be utilized. "There are enormous areas in the Federal Government where the use of financial incentives would be perfectly sound from a management point of view. There are important areas where even the heresy of piecework would be warranted."

In the latter part of the book where Mr. Juran presents his suggestions for reform, he suggests how financial incentives may be used. "The establishment of adequate standards of performance at all levels of organization is fundamental. Standards shall be established with respect to man-hours, cost, time, end results, or other appropriate measuring rod, using the best management techniques available." Performance relative to the standards thus established can be used as the basis for increased compensation within the job grade and for promotions from one grade to another.

But nonfinancial incentives should also be utilized. "The fact that incentive systems have traditionally been a tool for greater profits has given rise to a general impression that incentive systems are a part of the profit system. This impression is as erroneous as it is widespread. The laurel wreath, the *cum laude*, the parchment, the majority of votes, the honorary membership—all these and many other incentives bring out intense efforts from human beings whether they live under the profit system or not."

Mr. Juran does not ignore the magnitude and complexity of the job to be done nor the time that will be required to do it. The design may have to be years on the drawing board. We must not assume that the traditions, motives, and habits of years will give way at a moment's notice. The project must be sold not to a group of experts, but to the tens of thousands of bureaucrats who man the federal agencies. Improvement can come only from within.

STRESSES MANAGEMENT MINDEDNESS

Great stress is laid on the necessity of making these agencies "management-minded." The importance of the management function should be formally recognized by giving it a definite place in the organization setup. "Management consciousness is no less a state of mind than safety consciousness, and the same appeals to human interest and human competition can bring about management consciousness. This is so because the desire for participation and the desire for competition (and recognition) are among the strongest human characteristics. It is proposed here to harness to this program the desire for participation, for competition, and for recognition which Federal employees have in common with all other people."

As one means of developing this consciousness, the author proposes that there be established in each agency an administrative management pyramid paralleling the agency organization pyramid. The duty of the former would be to study the operation of the agency and make recommendations for improvement. Among other means of making the bureaucracy management-minded is employee participation. Considerable emphasis is placed upon the use of the suggestion system. "It provides management gossip. It gives instances of success to talk about. It causes people to see new outlines in familiar scenes. It provides a new sense of participation."

The author makes many other valuable suggestions which cannot be mentioned in a brief review. The reader may not agree that "the utilization of scientific principles of management in government to the same extent as is today practiced in progressive industry could cut the government population in half, and this while performing all the present functions with at least present effectiveness." But it will be difficult for a careful reader to avoid the conclusion that the application of the principles of scientific management to government would produce an amazing improvement in performance.

The problem of bureaucracy, as pointed out, falls into two parts, the appropriate functions of government and the management of the agencies to carry out these functions. But these are not separate problems. If the agencies are overstaffed and their effectiveness ruined by red tape, the public and the Congress will hesitate to trust the administration with additional duties. Such a situation might seriously retard the introduction of necessary social legislation. In other words, better management in government is more than a matter of reducing expenses. It involves the entire concept of Federal regulation over a complex society.

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Bureaucracy: A Challenge to Better Management," by J. M. Juran, Harper Bros., New York, N. Y., 1943, 138 pages, $2.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Steam Generation for Marine and Stationary Service

COMMENT BY G. N. MARTIN[1]

The achievements of the last 10 years in the field of steam-power engineering are treated in this paper,[2] together with the principal factors responsible for the rapid strides witnessed in the developments of land and marine power plants.

The general impressions retained from this presentation is that the prototypes of boilers were well established at the outbreak of war, and, aside from a few exceptions, the problem of steam generation in wartime has resolved itself into one of production.

Undoubtedly, the most favorable trial period for steam-generating units now exists. Results obtained thus far seem to have been sufficiently satisfactory to permit the author to express the opinion that standardization of design may follow after the war. The same opinion was expressed by Dr. Munzinger in 1936, before The Institution of Mechanical Engineers in London.

Canada is genuinely interested in this aspect of steam-power engineering. Our field of application is rather limited because of the fortuitous existence of hydroelectric developments. Therefore, generally speaking, we in Canada, more than in other spheres, have followed very closely the practice in the United States.

Water-cooled furnaces and pulverized-coal firing are used extensively in medium and moderately large installations. Drums are favored even for low-pressure units; one firm having built welded horizontal return-tubular boilers exclusively welded for several years. Today, welded drums are featured in the construction of marine boilers. The 4700-ton cargo ships now being built in Canada are equipped with completely welded Scotch marine boilers, and most of the boilers of the same type for the 9300-ton cargo ships are supplied with welded combustion chambers.

Another instance of Canada's progressiveness in the steam-power field is revealed in the equipment supplied for auxiliary power plants for several 3600-ton Diesel oil tankers. LaMont boilers of the forced-circulation type are being installed at present, having been built and designed in Canada.

The author mentions forced-circulation boilers in connection with the synthetic-rubber industry. Doubtless the decision reached to use natural-circulation boilers was a timely one. Apart from the disruption of established methods of production, a great deal of original design work and development of details would have been necessary. It was, presumably, judged more desirable to utilize the time available building well-known types of steam-generating units. However, several European forced-circulation-boiler manufacturers claim more substantial steel savings over natural-circulation boilers than mentioned by the author. Dr. Munzinger claims as much as 33 per cent in a boiler of the LaMont design built for 100,000 lb per hr at 1000 psi working pressure. On the other hand, if the heat recovery and firing apparatus are considered, the over-all saving in steel is only between 10 and 15 per cent. Perhaps this is the saving the author had in mind although he specifically mentioned 11 per cent of the boiler unit itself.

Another reason for the rejection of the forced-circulation boilers, mentioned in the paper, is the adverse water conditions which prevail.

Since forced-circulation boilers permit a relatively high velocity at every pressure and output, they are no more sensitive than ordinary designs operating on various chemically prepared feedwaters.

When forced-circulation boilers made their first appearance, this objection was presented endlessly. Undoubtedly, these boilers had to be operated with caution in connection with waters which form hard insoluble scale, since it is impossible to turbine the small-diameter tubes.

However, since chemical cleaning is now a generally accepted practice, as reported in the paper, this objection should not retain its original weight. In Europe, the use of an acid with an inhibitor has been dropped in many plants, and the acid is used by itself to clean the internal surfaces of the steam-generating units, in which case, no cast-iron parts should be used.

It cannot be claimed that such designs do not require feedwater treatment, but hardly any type of boiler of a certain size and pressure can afford to do without it.

The period of war preparation in Britain, from Munich to the battle of France, was very fertile in the development of central-station and industrial steam power plants. At that time the writer was temporarily connected with the British Central Electricity Board, and with one of Britain's main power-plant contractors, and would like to draw a parallel between the two nations in the preparation for the expansion of their war industries.

The American influence was felt in the size of the units installed. Larger boilers were built, working at a higher steam pressure and temperature than the units already in use. Welded drums were not used as extensively as in the United States. Since most of the boilers the writer came in contact with were high-pressure units, his experience has been with forged steel drums.

Due consideration was given to steam separation. Steam washing and drying in the drum are accomplished by means of baffles with equipment very similar to that used on this side of the Atlantic. The results obtained so far have been most satisfactory.

All of these new plants featured completely water-cooled furnaces. Several were radiant-type boilers without any of the so-called boiler heating surface. The gases were led from the furnace directly into the superheater space, with concurrent by-pass for control of the steam temperature. Some of these units were reheat boilers individually connected to 60,000-kw turbines.

The majority of these boilers burn pulverized coal. All the new installations are equipped with unit pulverizers. Several old installations of the bin-storage type are still in use.

Next to this method of firing, the chain-grate stoker is encountered most often, in contrast to the multiple-retort and spreader stokers in American plants of a certain size.

Most of the fuel burned is bituminous coal, one or two installations using pulverized anthracite; the latter, of course, requiring very special consideration of the

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[1] Dominion Bridge Company, Lachine, Quebec, Canada.

[2] "Steam Generation for Marine and Stationary Service in the United States, 1933–1943," by E. G. Bailey, MECHANICAL ENGINEERING, November, 1943, pp. 770–772.

furnace design. Some export units were designed for a combination of pulverized coal and blast-furnace gas. The arrangement for the latter form of firing necessitated the rather intricate design of water seals and combination burners, especially in connection with automatic combustion control.

In one plant designed to operate at 1500 psi, radiant boilers were installed alongside LaMont forced-circulation boilers, the capacities of the units being equal, and their methods of firing being the same. The results of their operation when they are released should not be devoid of interest.

For several months the writer also operated two Loeffler boilers rated at 210,000 lb per hr with 1900 psi working pressure. The operation of this plant was rather difficult at the outset, but the generators revealed their worth; over-all thermal efficiency of the plant being 32 per cent, which was the highest in the world at the time. Consequently, the owners issued a repeat order for larger units in 1940.

Completely automatic combustion control with superheat control were featured in all the central-station power plants built during this period.

Thus, generally speaking, all of the characteristics mentioned in the author's paper and featured in American plants were paralleled in British installations.

In both countries, the highest thermal efficiencies were achieved, an over-all economy was aimed at with the use of well-tried types of equipment.

Perhaps the next years of engineering research will be directed toward decreasing the maintenance and operating costs, largely in connection with cheap suitable feedwater treatment. While searching for such a formula, engineers may develop a new type of equipment, but it appears safe to predict with the author that, based upon the operating data obtained during this period of intense production, only slight variations in types of equipment in use to-day will result.

We may thus be thankful to the research workers and pioneers of only yesterday who have made it possible to the United Nations to equip themselves with efficient means of power production.

Comment by P. W. Thompson[3]

The author points out that war conditions have imposed heavier loads than ever before on steam-generating equipment and at higher use factors. It is this latter situation which is the more serious because of the difficulty in finding opportunity to take equipment out of service for inspection, repair, and cleaning, and yet meet the ever-increasing demand for power.

In Detroit we are particularly fortunate in having foreseen the possibilities of increased demand well in advance, and to have made plans accordingly. Although the maximum predicted demands on the steam-generating equipment have not yet been reached, the increased use factor and the restrictions on the use of materials have imposed some abnormal conditions, particularly in the field of maintenance, where it has been necessary to use certain substitute materials and to make repairs in a somewhat different manner than in normal times. For instance, the occasional failure of a boiler tube or an economizer tube may now involve cutting out the damaged section and welding in a short piece of tubing rather than making a complete tube replacement. Plate-type air preheaters have been patched rather than replaced. Arc welding has been used to build up worn or damaged parts to provide additional life rather than to replace them with new parts. In many cases, "necessity has been the mother of invention," and the new methods developed are being adopted as standard practice where the result is reduced cost without any sacrifice in reliability.

These new methods of maintenance, together with closer supervision and longer hours of work, have tended to offset the growing scarcity of labor and materials. As a result, the outage periods of boilers under repair are, in most cases, no longer now than they were previous to the war. However, scarcity of labor and materials has delayed improvements and replacements which normally would be undertaken to improve efficiency or plant conditions. For instance, in one plant where fouling of the economizer surface has resulted in frequent shutdowns for cleaning, the continuous operating period of the steam-generating units could be extended several months if improved soot-blowing equipment could be installed. At another plant the installation of new scroll casings and self-aligning bearings on draft fans would eliminate frequent repairs. The war has interrupted the installation of cinder and fly-ash collectors, a program which was under way in two plants. These and other similar items will add up to a considerable backlog of postwar work for our maintenance and construction forces.

It is interesting to note that very few difficulties have arisen as a result of the adoption of high steam temperatures. It is only within approximately the past 10 years that steam temperatures in excess of 750 F have been used in central stations in the United States, and it is to the credit of the metallurgists and those who conducted the fundamental research on materials to withstand these higher temperatures that the imposition of the more severe service conditions has not resulted in any appreciable reduction in availability.

In 1928, The Detroit Edison Company, working in conjunction with The Babcock & Wilcox Company, installed an experimental high-temperature superheater in one of its power plants for the purpose of obtaining information on materials and methods of construction which would lead to the adoption of higher steam temperatures in power generation. Later, at another plant, a larger high-temperature superheater and a turbogenerator of 10,000-kw capacity, purchased from The British Thomson-Houston Company of Rugby, England, were installed for the purpose of continuing experiments in the high-temperature field in a manner which simulated actual operating conditions. This combination of superheater and turbogenerator operated for several years with steam at 1000 F. Much valuable information was obtained which was used in the adoption of a steam temperature of 900 F for subsequent additions to the system generating capacity.

Other service experiments are being conducted on a superheater of quite different design from the conventional convection or combined radiant-convection type of superheater. The purpose of the design is to obtain a high degree of superheat with a minimum of surface and a minimum of control complications and, at the same time, to simplify the design of the boiler unit which now is built around the superheater. This experimental superheater is installed in a 330,000-lb-per-hr boiler fired with pulverized fuel. The superheater is a water-cooled radiant type and forms a portion of the furnace wall. It has been in service for more than 2 years and, although certain defects have developed, corrective changes in design have been made so that it is now performing with a fair degree of satisfaction. It is believed that such an arrangement of superheater may result in a reduction of the weight of material required, as compared with the convection-type superheater. It would simplify the design of the boiler unit and at the same time provide a means of controlling the degree of superheat within desirable limits over the full range of boiler steaming rates. War conditions have retarded the experimental work on this design, but as soon as conditions permit further developments will be resumed.

The author points out a very important factor affecting the efficiency of steam production, that is, equipping steam generators with the necessary instruments to guide the operator in maintaining efficient combustion. Under many conditions, automatic control of combustion is economically justified, particularly with

[3] Chief Engineer, Power Plants, Detroit Edison Company, Detroit, Mich. Mem. A.S.M.E.

pulverized-fuel-fired boilers. However, with properly trained operators, there appears to be little if anything to be gained in the automatic control of underfeed-stoker firing. In the four main plants of The Detroit Edison Company having a total installed capacity of over 1,100,000 kw, two thirds of the capacity is served by underfeed-stoker-fired boilers. The average over-all boiler efficiency for the year 1942 was 87.6 per cent for all boilers, and for the stoker-fired boilers alone it was 87.5 per cent. Three recently installed pulverized-fuel-fired boilers are equipped for full-automatic control, except for steam temperature. The control thus far has been manual so no results are yet available for comparison of manual versus automatic control. It is believed that, as additional boiler units are installed in this station, the units having automatic control will require less attending labor.

Mention is made in the paper of the fuel situation. Certainly more attention will be directed in the future to the utilization of by-product fuels, as coal and petroleum products tend to increase in price. For the past several years, stoker-fired boilers in one of The Detroit Edison power plants have burned excess blast-furnace gas containing 90 to 100 Btu per cu ft. The resulting gains due to less coal- and ash-handling expense have been offset to some extent by the increased slagging of boiler surfaces. The small amount of dust, approximately 0.01 g per cu ft, remaining in the gas after passing through washers and electrostatic cleaners has a material fluxing action on the coal ash. During 1942, the coal equivalent of gas burned amounted to 70,000 short tons, a worth-while contribution toward relieving the coal-transporting system.

In closing this discussion, it should be emphasized, as was done in the paper, that the knowledge gained in operating large stationary boilers at high loads and use factors is providing excellent information. Consideration of this operating experience, together with carefully prepared engineering studies, and the exercise of good judgment will be necessary in the selection of future equipment.

COMMENT BY ENGINEER REAR ADMIRAL G. L. STEPHENS, R.C.N.[4]

The writer's duties bring him in close association with the Office of the Chief of the Bureau of Ships, United States Navy, at Washington, so we are somewhat familiar with American naval-engineering practice. Considerably different engineering problems are presented in the Canadian Navy. We started the war with approximately 150 officers and men in the Engineering Branch. Today, we have approximately 20,000, which is a tremendous increase. As you know, this country did not have the trained personnel required, so we had to train them.

We have had two problems to contend with in connection with the engineering phases of building ships of the Canadian Navy; one has been the difficulty of finding operators and training them at a sufficiently rapid rate, and the other has been that of overcoming the manufacturing problem, where only limited production facilities existed at the start of the conflict.

This opportunity is being taken to pay tribute to those firms which have so nobly contributed to the solution of the manufacturing problems both of limited labor and plant facilities. Because of these two difficulties, we are obliged to keep our plants very simple. There is no use carrying out experiments in a ship at sea and discovering that something is wrong in the middle of the Atlantic, with a submarine attack on a convoy imminent; so we have not been able to adopt high pressure or high superheat, and no large power units have been installed. The largest is about 45,000 hp in one unit. However, at the present time we have units totaling nearly 1,000,000 hp in operation.

When the naval building program in Canada was initiated, our ships were equipped with Scotch marine boilers. Today, we are using water-tube boilers exclusively, and mostly of standardized designs.

The author's comments on automatic combustion control are of great interest. We limit automatic control to the supply of feedwater.

With the co-operation of the manufacturers of equipment in this country, we have sought diligently to reduce the consumption of oil and increase the efficiency of our boilers. The problem is complicated by the fact that fuel oil of many grades must be taken on at many different ports. The difficulty has been to find a burner that would operate efficiently under such varied conditions. Even the partial solution of changing nozzles is complicated when the necessity occurs with enemy action imminent.

It is of considerable interest to know that 6 months' operation of land boilers is possible between inspections. Normal naval practice requires that we open up our boilers every 600 hr. However, improvements in treatment of boiler feedwater, suggested by commercial firms and from knowledge gained by our own experience, permit an extension between inspections up to 1500 hr.

COMMENT BY A. R. MUMFORD[5]

It is my belief that in the next 10 years radical improvements may be possible in boiler design. While present-day boilers are good, they represent only limited advances of fundamental water-tube-boiler practice. When we know more about what is going on within the tubes, and in the circulation system generally, perhaps we can make more effective use of the available heat and recover that heat in a smaller space.

The problems of combustion are a challenge to all fuel engineers. In marine practice, as is well known, oil can be burned up to a liberation rate of 500,000 Btu per cu ft while our coal-furnace liberation rates are of the order of 20,000 to 30,000 per cu ft. It is up to the engineers to solve the problem of handling the noncombustible materials in the coal.

In land installations, the furnace volume must be cut down, at least approaching the volume of naval boiler installations where the liberation rates are extremely high. The writer does not subscribe to a continuation of the present trend in design but he believes that as engineers we can learn enough from current practice to make radical improvements in the boiler installations of the future.

COMMENT BY J. T. FARMER[6]

It would be helpful if the author would indicate to what extent it is justifiable to substitute steam atomization for mechanical atomization at this time.

The proposal to standardize steam turbines and steam conditions applying to same would be of advantage to the designing engineer in many ways. Once it was established that certain standard units were readily available, these could be used as a basis in working out the elements to meet the requirements of any normal system. This would eliminate the expenditure of time and work incurred, often rather futilely, in endeavoring to arrive at the most desirable combination with a wide choice of variables.

COMMENT BY J. W. ATKINSON[7]

What has been the experience with the large number of cargo ships of different sizes and different powers now being operated by the Maritime Commission, particularly with the class of personnel available? Has automatic superheat control proved satisfactory?

The author mentioned that standard practice for naval vessels is 600 psi working pressure and 850 F total temperature. There must be some difference in operating experience with such conditions, as compared with former practice of, say, 450

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[6] Mechanical Engineer, Montreal Engineering Company, Ltd., Montreal, Canada. Mem. A.S.M.E.

[7] John Inglis Company, Toronto, Ont., Canada.

psi and 700 F. Comment on performance at the higher conditions would be of interest. Also fuel consumption must come much closer to that of units of lower pressures and temperatures when fractional powers are utilized, which represent the cruising conditions in normal times.

Comment by A. G. Christie[8]

The author states that some special-purpose boilers are being designed with temperatures up to 1400 F. That immediately raises the question as to whether we are moving up above our 900-deg standard steam temperature.

In another line, we are working on turbine materials which will stand much higher temperatures than those at present employed. If these materials can also be used in steam-turbine design, then should steam temperatures be pegged at 900 and 960 F, or be allowed to move up past the 1000-deg mark?

Author's Closure

Mr. Martin has been very kind to give a fairly complete review of steam generation in both Canada and Europe within his personal experience. He mentions Dr. Munzinger's paper entitled, "Modern Forms of Water-Tube Boilers for Land and Marine Use" given before The Institution of Mechanical Engineers in London, November, 1936. It happened that I saw Dr. Munzinger in Berlin in July of that year and he went over with me many of the things which he was then preparing for this paper. Dr. Munzinger expressed to me verbally more than he has put in his paper regarding the advances in water-cooled furnace design and the burning of pulverized coal outside of Germany, and why such advances were not available to those in Germany. The reason for this was perfectly obvious to the two of us, and Dr. Munzinger in speaking of one particular feature in his paper said, "Their adoption in one country and rejection in another must be due more to national peculiarities than to technical considerations." I think we, as allied nations, should feel happy that Germany was too proud to copy some of the good things developed outside her borders.

As to the relative weight saving by forced-circulation boilers over natural-circulation, a few per cent more or less is of no consequence because it must be remembered that any set of figures is based on certain specific designs available to the estimator at the time, and as changes and improvements are made, these figures will vary accordingly. It must be remembered that as units increase in size the structural-strength problem becomes increasingly more difficult of accomplishment and tends to overcome the lesser weight of the small tubes utilized in forced-circulation units. It is believed, however, that experience indicates that natural-circulation boilers, even in our naval practice, can be further reduced in weight and size, while the design of forced-circulation boilers seems to have been overdone in reducing weight for satisfactory and continuous operating results and it is believed that the future will see less difference rather than more.

Mr. Thompson's discussion, coming as it does from one who has for many years been a leader in power-plant design and operation, is very much appreciated.

The lower average quality of fuel available is bringing into the picture another factor so that in the future more attention will be given to designing units for high-duty output and continuous operation with lower-grade fuels than many people previously anticipated. The general trend of the future will be toward coal, and lower grades of coal, than have heretofore been generally burned.

Boiler efficiencies are now available up to approximately 90 per cent, a figure which is very close to the probable practical maximum on account of inherent losses due to the sensible heat in flue gas between the exit gas temperature and the temperature of the incoming air for combustion. Even this maximum efficiency is seldom warranted because of practical considerations, principally the effect of low exit-gas temperature on corrosion of air heaters, and the larger question of cost of equipment to obtain such high efficiencies. The economic or financial efficiency should always enter the picture so that a thermal efficiency that can be justified by the load factor and the price of fuel and cost of maintenance, be chosen.

As steam temperatures have increased above the 750-degree range, the selection of proper material for, and the design of superheaters has become more and more important. The present use of 950 degrees has been justified by the development of suitable heat-resisting alloys and the careful selection of the location for the superheater in order that it might withstand the temperatures to which it is subjected. To a considerable degree Mr. Thompson's statement, that steam-generating units are built around the superheater, is correct; although it seems equally important to have the furnace designed properly to tolerate the type of fuel and ash to be handled. It is, however, especially pertinent that all designers continue a search for the ideal superheater arrangement and type of design, and Mr. Thompson's efforts in this direction, I am sure, are appreciated by the industry.

The comments of Rear Admiral G. L. Stephens are very much appreciated, and certainly he and his associates have done remarkably well in building up an organization trained to do what is being done.

As to the extension of the period between boiler inspections in Navy ships, a little over three years ago 700 hours was the specified time interval between such inspections in the United States Navy. The 1943 edition of chapter 51 of the Bureau of Ships Manual of the United States Navy Department says, "Boilers shall not be steamed more than 1800 to 2000 hours between successive cleaning periods"—(51–153a). In special cases, where careful check has been kept on the feed and boiler water, this time interval has been extended to as much as 2600 hours.

Mr. Mumford very characteristically throws in a flash of optimism on radical changes; and I fully agree that with radical improvements and new methods of burning fuel, both oil and coal, that new furnace and boiler designs will result. However, most developments go in cycles in which radical improvement extends over a period of years then flattens out to a satisfactory commercial utilization of the advances for a period of time, but not, of course, forever. I believe we are approaching a leveling off cycle. We did have the advantage of the interim between the two wars to make radical improvements in combustion of fuel and design of boilers, and this war has been fought with equipment that was not fully standardized but was leveled off to a higher plane by far than that heretofore available. The culmination of operating experiences during this high-duty critical period will further sift out and evaluate the unfinished business as it now stands.

No doubt, further improvements in burning fuel—perhaps even radical ones—will be brought forward within the next few years, and after a certain amount of individual, and more or less indiscriminate, experimenting which will follow, the boilers ultimately will be redesigned according to the new fuel-burning methods, superheat requirements, and so on ad infinitum.

Replying to Mr. Farmer's remarks, the use of steam as an atomizing medium assures a finer division of the oil spray than is possible with mechanical atomization at the oil pressures currently employed for the latter. This results in a faster-burning fire under otherwise identical furnace conditions. If relatively large and hot furnaces are available there will be no advantage in using steam for atomization if the load is a constant one. If the furnace has a large percentage of water-cooled surface, steam atomization will generally give better combustion performance than mechanical

[8] Professor of Mechanical Engineering, Johns Hopkins University, Baltimore, Md. Past-President, A.S.M.E.

atomization, especially if combustion air at room temperature is used.

To meet variable load conditions with mechanical atomization, it is necessary to cut burners in and out as the range of a mechanical atomizer due to pressure change alone is only about two to one. If low oil pressures are used (less than 100 psi) the atomization becomes very coarse and poor combustion efficiency results. The use of steam assures a uniform quality of atomization over wide ranges of load and correspondingly consistent efficient combustion conditions. This is particularly valuable if an automatic-combustion-control system is used, as it assures optimum combustion results over wide ranges of operation without any manual attention.

The preferred type of steam atomizer is one which discharges a cone-shaped oil spray and is used with a circular air register of the type commonly employed with mechanical atomizers.

Standardization of pressure and temperature, like all other moves toward simplification of design problems, would be helpful in the steam-generating field; on the other hand, the pressure and temperature for a given unit has less effect upon its cost and upon the amount of work involved in its design than do the other factors of size, arrangement, building limitations, and fuel requirements, and therefore should not be looked upon as any large and valuable goal to be sought. The standardization of piping and piping material for certain pressure ranges tends to standardize the pressure and temperature for which boilers are designed, but in spite of this there are always some engineers who hold out for their individual opinions, and this, plus the other variables in the picture, has in large measure prevented a realization of any appreciable amount of standardization in pressure and temperature.

Mr. Atkinson's questions are very timely. The experience to date with the large number of cargo ships now being operated by agents appointed by the War Shipping Administration has been most satisfactory in view of the personnel problem referred to by Mr. Atkinson. Every effort is made to place a small experienced group on each ship to guide the newer men. The picture has been appreciably helped by the training schools operated under the direction of the Maritime Commission, so that even the new men have a working knowledge of the essentials of their job before reporting for duty.

Automatic superheat control has been used in only a few installations in ships of the U. S. Merchant Marine, but where it has been used it has been satisfactory and reliable.

The practical effect of using 600 psi and 850 F compared to 450 psi and 700 F steam over the normal operating speeds of Navy vessels is subject to a number of variables, including the design of propulsion machinery and auxiliaries, which fall outside the scope of this paper on steam generation. Due to the use of economizers on boiler units for both of the pressures mentioned, there is no measurable difference in the efficiency characteristics of such units, so that the steam generation by itself is not a factor in the cruising radius of these vessels.

Professor Christie raises a question in regard to the 1400 F steam temperature for the production of butadiene. It should be recognized that this steam is used at less than 50 lb pressure and therefore adds little experience that will be useful for high-pressure turbine operation. It is believed that we may reach, or possibly exceed, steam temperature of 1000 F within the next few years on units up to 2000 pounds pressure—a little more or less.

E. G. BAILEY.[9]

[9] Vice-President, The Babcock & Wilcox Company, New York, N. Y. Fellow A.S.M.E.

Fuels and Fuel Research in Great Britain

COMMENT BY W. T. REID[10]

Little experience with portable gas producers has been available in the United States; thus the description, given in this paper,[11] of the use of these devices in Great Britain should be of wide interest to all, if not from the standpoint of increased utilization of solid fuels, then as consumers of transported products and as a traveling public. Whether or not the availability of petroleum in this country in the future will be as bad as recent reports on reserves and new discoveries would indicate, the utilization of coal or coke as a fuel for our automotive transportation system is too good an opportunity to overlook. Each of the 28,000,000 automotive vehicles in this country before the war is a potential customer for solid fuel without requiring modification of the existing engine in any way, necessitating only the addition of the admittedly cumbersome gas producer and its associated filters. It is quite probable that should the need arise, the size of these devices could be decreased considerably, with consequent greater consumer satisfaction.

The author wisely stresses the difficulties in the operation of portable gas producers in Great Britain, yet admits that these difficulties have been surmounted to a considerable extent. Probably the motoring public in this country will never accept producer gas as a substitute for liquid fuels, not because of dissatisfaction with performance, which is only about 60 per cent of that on gasoline with the same engine, but because of operating troubles, including delayed starting, refueling at intervals as short as 100 miles, and the cleaning of fuel beds and filters. However, to commercial users such as the operators of fleets of trucks or buses, with trained mechanics and experienced operating personnel, these difficulties are largely minimized, and portable gas producers may be readily accepted if shortages in gasoline continue, or if the prices of petroleum products increase markedly.

Not the least of the attractions of the producer is the item of fuel costs. Fuel consumption of most producers will be less than 1 lb per gross-ton-mile, which, at a cost of $10 per ton of fuel, is at the rate of 0.5 cent per gross-ton-mile. As an example of comparative costs, a lightweight passenger car, weighing approximately 3000 lb, would cost 0.75 cent per mile for producer fuel, but about 1.2 cents per mile for gasoline under favorable conditions.

Already, in the United States, experimental units have been installed on a few commercial vehicles by curious operators who see a possibility of maintaining service without reliance on rationed gasoline.

As an example of the operating characteristics of one such experimental installation in this country, the following observations are reported. The producer was of the up-draft type and was fired with charcoal; it was installed on a $2^1/_2$-ton truck loaded to rated capacity. After operation of the engine for 1 min with gasoline, the charcoal was ignited with a kerosene-soaked torch, change-over from gasoline being made gradually so that $2^1/_2$ min later the engine was running entirely on producer gas. Four minutes after igniting the charcoal, the truck was being driven away on producer gas with no more difficulty than if the fuel had been gasoline. During the ensuing tests, speeds of 40 mph were attained on a level road, but because the tests were made in level country no runs were tried on steep grades; the drivers, however, agreed that on hills, approximately one lower transmission gear would be required with producer-gas as compared to

[10] Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior. Supervising Engineer, Fuels Section, U. S. Bureau of Mines, Central Experiment Station, Pittsburgh, Pa. Mem. A.S.M.E.

[11] "Fuels and Fuel Research in Great Britain During the War," by W. C. Schroeder, MECHANICAL ENGINEERING, December, 1943, pp. 881–884, and 892.

gasoline. Operation on producer gas was demonstrated to be less rough at low speeds than with gasoline; the engine accelerated smoothly in high gear at full throttle from a speed of less than 5 mph without bucking or stalling, and no ignition knock, or detonation, was heard at any time. The engine could be restarted on producer gas alone without assistance from gasoline after stops of as long as 30 min, indicating its suitability for "stop-and-go" driving, such as in delivery service. The fuel consumption over a distance of slightly less than 500 miles was 0.57 lb per gross-ton-mile.

Although the fuel used in these tests was charcoal, it is obvious that insufficient charcoal will be available in the United States to operate any considerable number of portable gas producers, except possibly for farmers who may make their own charcoal from available woodlots. Thus the problem arises of substituting other solid fuels, such as anthracite or coke, or char made from subbituminous or lignitic coals as domestic fuel for these producers. Also, charcoal sells at approximately $40 per ton at the present time, as compared to $8 to $12 per ton for fuel prepared from coal. Very little information is available on the effects of such fuels on the performance characteristics of portable gas producers; research is needed in this country on the evaluation of typical American fuels for this purpose.

Author's Closure

The discussion by Mr. Reid points out that in certain applications the inconvenience commonly associated with the portable gas producer may not be a major item of consideration. This is undoubtedly correct and the problem should not be viewed only as one of concern to the private automobile owner.

Recent reports from Germany indicate that practically all transportation, even including that to the fighting fronts, is now using portable gas producers. This is undoubtedly indicative of a growing petroleum shortage. Development work on this equipment has by no means stopped in Great Britain in spite of difficulties so far encountered. In the United States, it would seem to be the part of wisdom to carry on at least some development work to meet any emergency in liquid-fuels supplies either within the country, or in its outlying possessions.

W. C. Schroeder.[12]

[12] Assistant Chief, Fuels and Explosives Service, Bureau of Mines, Washington, D. C. Mem. A.S.M.E.

Nathan S. Osborne

To the Editor:

Nathan S. Osborne, principal physicist at the National Bureau of Standards, died at his home in Washington, D. C., on Sept. 18, 1943, after a long illness. Born at Southhampton, N. Y., Feb. 10, 1875, he attended the public schools in Southhampton and the Michigan College of Mines, where he received the degree of Mining Engineer and membership in Tau Beta Pi in 1899. The next few years were spent partly in the practice of mining engineering and partly as instructor in mathematics and physics at the Michigan College of Mines. His real bent, however, was for precise physical measurements, and his opportunity came when he joined the staff of the National Bureau of Standards in 1903. He served, until his death, as a member of the staff of the Bureau for a total of 38 years with the exception of a period from 1910 to 1912, during which he was an instructor at the Michigan College of Mines.

He was married in 1910 to Lura M. Krebs and is survived by her, by a daughter, Mrs. Douglas Robertson, and a son, Robert.

His first major scientific investigation was of the density and thermal expansion of ethyl alcohol and its mixtures with water. The tables based on the data obtained are still the standard of the U. S. Treasury and other Departments of the Federal Government, and are widely used in industry.

He returned to the Bureau in 1912 to participate in and later to take the leading part in the determination of the physical constants of interest to the refrigerating industry. After a series of determinations of the specific heat and heat of fusion of ice, the work on properties of ammonia was begun. This investigation covered the entire range of temperature and pressure likely to be useful in refrigeration and included determination of the properties of saturated liquid and saturated and superheated vapor. The work was extensive enough to provide a basis for complete tables of the thermodynamic properties of ammonia, published in 1923. These tables were accepted both here and abroad as authoritative and are still considered so by the engineering profession.

By far the most important working substance of the engineer is, however, steam, and when it became obvious in the early 1920's that there was considerable international disagreement as to which of the divergent steam tables should be accepted as the basis for acceptance tests, the A.S.M.E. undertook to form a Steam Tables Committee under the chairmanship of Geo. A. Orrok. Dr. Osborne was an obvious selection as a member of the committee and served on it enthusiastically and effectively throughout its existence. Considerable funds were raised from the steam-power industries to finance new research, and an important part of this work was assigned to the Bureau of Standards under Dr. Osborne's direction.

The ammonia program had consisted of a series of separate investigations which were brought together and correlated after completion. Dr. Osborne was not satisfied with this rather unsystematic procedure, and before beginning the researches in water and steam, he worked out a much more systematic method of dealing with the problem, published under the title, "Calorimetry of a Fluid." In this paper he outlined and described a procedure for determining the principal thermodynamic properties of a liquid and its vapor, using a suitably designed calorimeter for a series of correlated measurements. This method was the basis for his work on the properties of saturated steam. He also planned an extension of the method to include some of the properties of the superheated vapor, but this part of the method has not yet been used.

Although educated as an engineer, Dr. Osborne attained eminence in the engineering world, not through the practice of his profession, but by contributing for its use some of the fundamental physical data which are the foundation of engineering. His work has received wide recognition, as in the International Steam Tables, the two-phase part of which is largely based on his work. He was a delegate to the three International Conferences on the Properties of Steam, held in England, Germany, and the United States in 1929, 1930, and 1934, respectively, and contributed much to their success. He was honored with the degree of Doctor of Science by Stevens Institute of Technology and the degree of Doctor of Engineering by the Michigan College of Mines. He was a member of the Philosophical Society of Washington and of the Washington Academy of Sciences.

It is fortunate that his work was done at a time when the equipment for measurements of temperature and pressure, and other factors required, had been perfected to such an extent that in combination with his own developments in calorimetry, the accuracy attainable and actually attained was ample for engineering purposes and adequate for present-day scientific requirements. It seems possible that the results of his work will be considered as definitive, and there is at present no prospect that the work will need to be repeated for many years to come.

In the design and construction of the apparatus required for his work, Dr. Os-

borne was reluctant to follow conventional practice until he had convinced himself that it was better than any new and original methods that he could devise. He became a skilled instrument maker and himself constructed some of the more delicate and difficult parts of his apparatus and produced some examples which could bear comparison with the product of the most skilled mechanics. He was always ready to give the benefit of his ideas and experience to anyone who asked for it and in this way made many valuable contributions to the work of others.

E. F. MUELLER.[13]

[13] Physicist, National Bureau of Standards, Washington, D. C.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of February 11, 1944, and approved by the A.S.M.E. Council on March 13, 1944.

CASE No. 981 (REOPENED)

(Special Ruling)

Inquiry: Is it permissible to use the following A.S.T.M. Emergency Alternate Provisions affecting existing Code specifications: EA-A30(SA-30), EA-A70(SA-70), EA-A83(SA-83), EA-A89(SA-89), EA-A135(SA-135), EA-A158(SA-158), EA-A178(SA-178), EA-A192(SA-192), EA-A194(SA-194), EA-A201(SA-201), EA-A202(SA-202), EA-A203(SA-203), EA-A204(SA-204), EA-A206(SA-206), EA-A209(SA-209), EA-A212(SA-212), EA-A213(SA-213), EA-A216(SA-216), EA-A217(SA-217), EA-A226(SA-226), EA-A240(SA-240), EA-A249(SA-249), EA-A250(SA-250), EA-B12(SB-12), EA-B61(SB-61), EA-B62a(SB-62), EA-B111(SB-111), EA-B171(SB-171)?

Reply: It is the opinion of the Committee that the afore-mentioned A.S.T.M. Emergency Alternate Provisions in corresponding Code specifications may be considered as meeting the intent of the Code.

CASE No. 1005

(Interpretation of Par. P-112c)

Inquiry: May backing rings of other dimensions and design than indicated in Fig. P-7 be used in constructions provided for in Par. P-112(*c*)?

Reply: It is the opinion of the Committee that based upon the proposed revision published in MECHANICAL ENGINEERING for May, 1943, backing rings of any design may be used and left in place or removed after welding in constructions covered by Par. P-112 as follows:

Backing rings may be left in place or removed as desired, but if left in place they must be properly secured to prevent dislodgment and shall have a contour on the inside to minimize the restriction to flow, if needed, and be of such inside diameter as to permit the passage of a tube cleaner where such cleaner is to be used. Backing rings may be of any size, shape, or material suitable for the welding process.

Whether backing rings are removed or left in place, they shall be of such material and design that their use will not cause defects in the weld. (Particular attention is called to the possibility of high sulphur content of backing-ring material producing cracks in the weld metal.)

If the pipe or tube wall is recessed for a backing ring, the depth of such recess shall be so limited that the remaining net section of the wall is not less than the minimum required thickness.

CASE No. 1006

(Interpretation of Par. P-102h)

Inquiry: Assuming that the removal of the weld surface irregularities is for the purpose of avoiding the danger of misinterpreting the radiograph, in which some defect might be hidden or confused with such surface irregularities, is it permissible to eliminate any mechanical treatment of the weld surface: (1) when the surface irregularities are so small that they produce no contrast on a radiograph in the making of which the optimum technique was observed; (2) when the contrast due to surface irregularities is so negligibly small as to avoid any danger of masking cracks or other defects?

Reply: It is the opinion of the Committee that the mechanical treatment of the weld surface shall be such as to avoid all danger of having any harmful defect masked by or confused with the radiographic contrast due to surface irregularities, and providing the other provisions of Par. P-102(*h*) are complied with.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

FOREWORD. The following is to be added to the Foreword of every section of the Code:

Revisions and Cases are permissible for constructions to be stamped with the A.S.M.E. Code symbol beginning with date of A.S.M.E. Council approval printed thereon. Code revisions and Cases become effective as minimum requirements six months thereafter, except for boilers or pressure vessels sold, constructed, or under construction, prior to the end of the six-month period. Manufacturers are cautioned that permission to use revisions and Cases, if less restrictive than previous requirements, should be obtained from the proper authorities of the state or municipality in which installation is to be made unless such

jurisdiction has, specifically or automatically, adopted such revisions and Cases.

Table P-2. This table will be revised to be identical with Table P-2X shown in Case No. 968. Revise the formulas accompanying this table and Note 5 as follows:

$$P = \frac{2.875\,S\,(t - 0.04)}{D} - 0.045\,S$$

$$(A)\quad P = \frac{25875\,(t - 0.04)}{D} - 405$$

$$(B)\quad P = \frac{34500\,(t - 0.04)}{D} - 540$$

$$(C)\quad P = \frac{2.875\,St}{D} - 0.045\,S$$

5 Formula (C) may be used for determining the maximum allowable pressures for seamless steel tubes WHICH ARE STRENGTH-WELDED TO HEADERS OR DRUMS [for forced-circulation water-tube boilers] within the limitations of Par. 2 of these notes.

Tables P-7 and U-2. Revise as follows:

Add the following values:

	Spec. SA-213 Grade T13	Spec. SA-157 Grade C5B
Notes	. .	(7)(8)
Spec. min. tensile, psi	60,000	90,000
Metal temperatures, F	. .	. .
—20 to 650	12000 psi	15000
700	12000	15000
750	12000	15000
800	11800	14000
850	11000	12500
900	8800	8800
950	6000	6000
1000	4200	4200
1050	3000	3000
1100	2000	2000

For Specification SA-157, add stresses for Grade C5A, to be identical with those now given for Grade C5, which latter grade has been dropped.

The stresses now given for Specifications S-4 are to be used for Specification SA-266.

Specification SB-42. Add a new item (1) in Par. 2 reading: "(1) Temper (Par. 4)."

Specification SB-75. In Par. 2 add a new item (3) to read: "(3) Electrical or nonelectrical conductors (Par. 10)." In Par. 4 change the requirements for copper content of type D from "99.90 min" to read "99.92 min" per cent.

Specification SB-111. In Par. 3(*a*) add a reference to the Tentative Specifications for Electrolytic Cathode Copper (B115–41T) as suitable for use in the manufacture of materials covered by these specifications.

Specification SA-201. Revisions will be made in Pars. 1, 4, 8(*b*), and 9 which involve increasing the thickness limit specified in the scope clause for firebox plate from a maximum of 6 in. to a maximum of 12 in. for Grade A, with appropriate changes in the carbon and ductility limits for the heavier plates and the expansion of Table 2 covering permissible variations in thickness to provide for plates over 6 in. to 12 in.

Specification SA-89. In Par. 3(*a*) revise the chemical composition by changing the manganese content on all four grades in Table 1 from "0.035 to 0.60" to read "0.80 max" per cent.

Specification SA-266. Specification SA-266 has been adopted to replace Specification S-4. References to Specification S-4 in Pars. P-2(*d*), P-103, U-71(*a*), U-120, and Table Q-5 will be replaced by a reference to "SA-266."

Par. U-139. The following new paragraph is proposed:

U-139 Jacketed Vessels. (*a*) The inner wall thickness of a jacketed vessel, including the head, shall be computed for both internal (if necessary) and external pressure and the larger resulting value shall be used.

jacket space shall not exceed 2 in. in width;

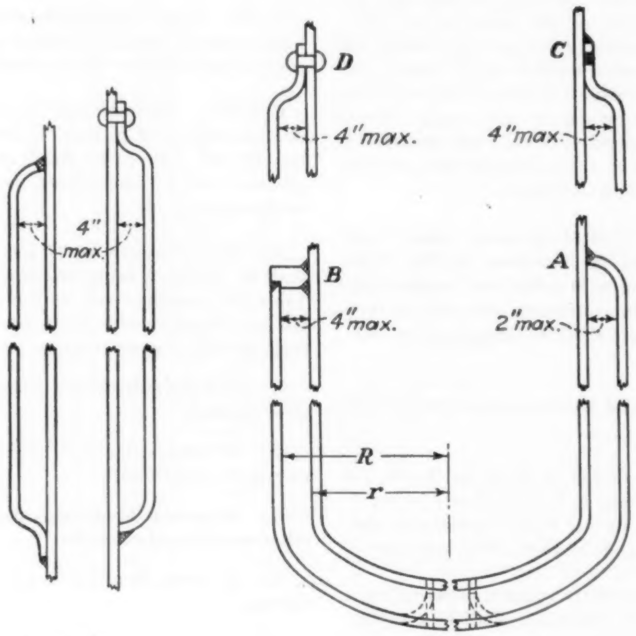
(2*b*) The thickness of the closure bar in method *B* shall be not less than that determined by the formula:

$$t = 1.225\sqrt{\frac{PDW}{S}}$$

where

P = jacket pressure, pounds per square inch,
D = outside diameter of inner vessel, inches,
W = width of jacket space, inches,
S = allowable unit stress in material of closure bar (Table U-2), pounds per square inch.

(2*c*) If the method of attachment as shown at *C* is used, the shearing stress on the fillet weld shall not exceed 4000 psi, and that of the plug welds shall not exceed 8000 psi. Plug welds sufficient to carry at least 50 per cent of the total load shall be used.



(*a*) (*b*)

FIG. U-21½

(*b*) An unstayed cylindrical jacketed vessel shall not have a jacket space wider than 4 in. If the vessel is of one of the following types, the jacket may be attached by any approved method. Some of these are shown in Fig. U-21½:

(1) Those that have a cylindrical part only, as shown in Fig. U-21½(*a*). Any method of attachment to the vessel may be used;

(2) Those that are cylindrical but extend around the bottom of the vessel without stays, as shown in Fig. U-21½(*b*). If the jacket is to be, or can be, subjected to vacuum it shall be checked forthat condition. The method of attachment to the vessel by welding may be either of the four shown at *A*, *B*, *C*, or *D*.

The shearing stress per inch of circumference when the jacket is attached to the inner shell, $s = Pr/2$.

(2*a*) The shearing stress of the weld for method *A* shall not exceed 4000 psi and the

The diameter of the plug welds shall be approximately the thickness of the plate plus $^5/_{16}$ in. In welding plug welds, a fillet around the bottom of the hole shall first be deposited and the hole shall then be entirely filled if the thickness is $^5/_8$ in. or less. Holes in thicker plates shall be filled at least $^5/_8$ in., but not less than one half the plate thickness.

The ligaments between holes and the distance from the edge of the plate must comply with the requirements for riveted construction.

(2*d*) If an outlet rigidly connecting the inner and outer heads is used, of which two possible arrangements are diagrammatically indicated in Fig. U-21½(*b*), the outlet construction shall be designed to carry a load equal to one half the load on the outer head, $^1/_2 L = \frac{P\pi R^2}{2}$.

(2*e*) If riveted, the joint *D* shall be calculated as a circumferential joint.

(3) Jacketed vessels must be stamped on the appropriate part in accordance with Par. U-66 and in addition to the type of welding with either or both "U-120" or "U-139."

NOTE: It is recognized that there may be many variations in design but to them the foregoing principles shall be adapted as far as practicable. Anticipated temperature differentials between the inner and outer walls should be provided for.

ALTERNATE RULES FOR UNFIRED PRESSURE VESSELS

Alternate rules for the construction of fusion-welded unfired pressure vessels are given in Pars. U-200 to U-210, inclusive, which permit liberalization of design stresses and welded joint efficiencies, under certain restrictive construction rules which must be met in order to use the higher stress allowances. These rules apply only to seamless vessels and to fusion-welded vessels constructed under the provisions of Pars. U-68 and U-69, and to tubes for use in such vessels. Other applicable provisions of the Code, not specifically covered by these alternate rules, must be complied with in all respects.

U-200(*a*). Unfired pressure vessels constructed under the provisions of Par. U-68, and complying with other Code requirements except for the variations allowed in these alternate rules, shall be designated as Par. U-200 vessels.

(*b*) A welded joint efficiency of 95 per cent may be used.

(*c*) In the design of shells and heads, the maximum stresses in Table U-2 may be multiplied by 1.25 for use in the formulas of Par. U-20(*a*), (*b*), and (*c*), U-36, U-39, and U-59.

(*d*) The restrictive requirements of Pars. U-202 to U-207, inclusive, shall be complied with in all respects.

U-201(*a*) Unfired pressure vessels constructed under the provisions of Par. U-69, and complying with other Code requirements except for the variations allowed in these alternate rules, shall be designated as Par. U-201 vessels.

(*b*) A welded joint efficiency of 85 per cent may be used.

(*c*) In the design of shells and heads, the maximum design stresses of Table U-2 may be multiplied by 1.25 for use in the formulas of Pars. U-20(*a*), (*b*), and (*c*), U-36, U-39, and U-59.

(*d*) The restrictive requirements of Pars. U-202 to U-208, inclusive, shall be complied with in all respects.

U-202. To the calculated thickness of shells, heads, and other pressure parts of steam, water, and air vessels shall be added a corrosion allowance of one sixth of the calculated thickness, or $^1/_{16}$ in., whichever is the smaller. Vessels in other corrosive services shall be provided with appropriate corrosion allowances.

U-203. The weld reinforcement for Par. U-200 vessels shall be removed flush with the surface of the plate. For both Pars. U-200 and U-201 vessels, where edges of unequal thicknesses are abutted, the thicker plate shall be trimmed to a smooth taper extending for a distance at least four times the offset between the abutting surfaces so that the adjoining edges will be of approximately the same thickness. All other joint details shall conform to the requirements of Par. U-72.

U-204. Stresses due to hydrostatic head shall be taken into account in determining the thickness to be used, also the total of other stresses due to loads such as the weight of the vessel, water, and distances between vessel supports, if these stresses increase the average stress over substantial sections of the shell or head by more than 10 per cent.

U-205. Large temperature differentials in heads or shells shall be avoided or the effect reduced by shields or other suitable means.

U-206(*a*). For heads, the increased design stresses authorized in Pars. U-200 and U-201 may be used only for flat heads and for hemispherical or ellipsoidal heads with pressure on the concave side.

(*b*) The following heads and other parts shall be designed using stresses as given in Table U-2 (without any multiplying factor) but may be used with shells constructed according to these alternate rules:

(1) Dished heads, other than hemispherical or ellipsoidal;

(2) All unstayed dished heads with pressure on the convex side;

(3) Ellipsoidal heads with flanged-in and other unreinforced manholes;

(4) All stays, braces, and parts requiring staying;

(5) Flanges.

U-207. In determining the maximum size of an unreinforced opening under Par. U-59(*a*), the value of *K* to be used in connection with the chart in Fig. U-5 shall be 1.1 times the value of *K* computed by the formula of that paragraph for the part of the shell that contains the opening. When computing *K* by the formula in Par. U-59(*a*), the pressure *P* shall be that for which the vessel is designed, *S* shall be 1.25 times the value from Table U-2, and *t* shall be the actual full thickness of the shell at the location of the opening. Where *K* so computed is unity or greater, the maximum size of unreinforced opening shall be 2 in.

U-208(*a*). Vessels constructed in accordance with Par. U-201 shall comply with the fusion welding requirements of Par. U-69; and in addition portions of the completed welded joints shall be examined either by spot radiographing, or by sectioning, or by a combination of both methods.

(*b*) When the welded joint is to be examined by spot radiographing, the requirements of Par. U-68(*b*) shall be satisfied.

(*c*) When the welded joint is to be examined by sectioning, the specimens removed shall be such as to provide a full cross section of the welded joint and may be removed by trepanning a round hole or by any equivalent method.

Cylindrical specimens or those not having a plane surface shall be sectioned across the welds to obtain plane surfaces which shall include the full width of the weld. The plane surfaces shall be prepared for examination as required in Par. U-78(*g*).

Sections removed from the welded joint shall show neither cracks nor lack of fusion, and only permissible amounts of slag inclusion and gas pockets as defined in Par. U-78(*g*).

Openings resulting from the removal of specimens may be closed by any method approved by the authorized inspector. Some acceptable methods for closing openings resulting from trepanning are given in Par. U-78(*g*).

(*d*) At least one spot shall be examined in each vessel except that when there are a number of similar vessels, each having less than 50 ft of welded longitudinal and circumferential joints, built at the same time and under the same specifications, one examined spot for each 50 ft or fraction thereof will suffice; two spots shall be examined in vessels having more than 50 ft of welded joints; and three spots shall be examined in vessels having more than 100 ft of welded joints. If more than one welding procedure is used or if more than one operator does the welding, at least one spot shall be examined for each procedure and for each operator.

The authorized inspector shall designate the spots on the welded joints to be examined.

(*e*) Retests. When a spot has been examined and the welding does not comply with the quality requirements referred to in (*b*) and/or (*c*), additional spots may be examined under the conditions set forth in Par. U-78(*g*), either by spot radiographing or sectioning. And if more than one of the additional spots examined reveals nonacceptable defects, the vessel may be rejected; or the welds within the proved limits of the defective joint shall be chipped or melted out from one or both sides of the joint as required and be rewelded.

All replacement welds in joints shall be checked by repeating the original test procedure.

U-209. In the determination of thicknesses for internal pressure of ferrous tubes and pipes used as tubes, the design stresses in Tables U-2 and U-4 may be multiplied by 1.25 for use in the formula in Par. U-20(*e*).

U-210. Unfired pressure vessels constructed in accordance with these alternate rules and with all of the other applicable Code rules shall be stamped with the Code symbol in accordance with Par. U-66. In addition, vessels welded under the provisions of Par. U-200 shall be stamped "U-200;" and those welded under the provisions of Par. U-201 shall be in a like manner stamped "U-201."

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Medical Aspects of Aviation

Medical Aspects of Aviation (Speed and Acceleration). By Capt. Ernst Jokl, M.D. Sir Isaac Pitman & Sons, Ltd., London, Eng.; Pitman Publishing Corporation, New York, N. Y., 1943. Cloth, $5^1/_2 \times 8^1/_2$ in., 104 pp., 122 figs., $3.

Reviewed by Eugene F. DuBois

THE effects of speed and acceleration on pilots are becoming major factors in the design of aircraft and it is important that they should be studied by engineers. Jokl's little book describes these effects clearly in a popular style without many data and without references. He does give good descriptions of "blacking out" in dives and turns. There is a brief account of the forces in parachute jumps and a short but good discussion of deceleration injuries and the principles involved in protecting pilots in crashes at moderate speeds. There are numerous illustrations, most of them good, many quite irrelevant.

Dr. Ernst Jokl has been Head of the Department of Physical Education, Witwatersrand Technical College, Johannesburg, South Africa. His book on the "Medical Aspect of Boxing" (1)[1] was well received. In 1942 he published a booklet on "Aviation Medicine" (2) similar to the one here reviewed but curiously enough he does not mention it in the present volume. His publications are readable and deserve attention but they are not nearly as complete as the larger standard works on aviation medicine (3, 4, 5). The discussion of acceleration in Ruff and Strughold (4) is much more informative. The many confidential reports of the armed services will not be available until the end of the war. It is to be hoped that someday we shall have an authoritative work on speed and acceleration that will consider both the machine and the man.

[1] Numbers in parentheses refer to References at end of this review.

REFERENCES

1 "The Medical Aspect of Boxing," by E. Jokl, Pretoria, J. L. Van Schaik, Ltd., 1941.

2 "Aviation Medicine," by E. Jokl, Unie-Volkspers Beperk, Cape Town, 1942, 213 pp.

3 "Principles and Practice of Aviation Medicine," by Col. H. G. Armstrong. Williams and Wilkins Co., Baltimore. Second edition, 1943.

4 "Compendium of Aviation Medicine," by S. Ruff and H. Strughold (Berlin, 1939?). Translation from the German reproduced in multigraph under a license granted by the Alien Property Custodian, 1942.

5 "Fundamentals of Aviation Medicine," Pavlov Institute of Aviation Medicine. Translated from the Russian by I. Steiman. Distributed under the auspices of the Associate Committee on Aviation Medicine of the National Research Council, Canada, 1943. (Canadian confidential, U. S. restricted.)

Six Quaker Clockmakers

Six Quaker Clock Makers. By Edward E. Chandlee. The Historical Society of Pennsylvania, Philadelphia, 1943. Distributed by David McKay Co., Philadelphia, Pa. Fabrikoid, $7 \times 9^1/_2$ in., xvii and 260 pp., 163 illus., $10.

Reviewed by P. R. Hoopes[2]

DURING the eighteenth century clockmakers of the middle colonies were pre-eminent among Americans for the quality, variety, and numbers of clocks which they produced. Mr. Chandlee has searched the records and set down the facts concerning one of the hitherto little known clockmaking families of that part of the country. He has photographed and reproduced scores of clocks made by his six Quakers between 1709 and 1811, has illustrated a number of surveying instruments and sundials, which they made, and has listed in detail the tools and materials which were inventoried in their estates. The admirer of colonial cabinet work will find here a superb series of illustrations of clock cases showing in chronological sequence the changing styles of eighteenth-century cabinetmaking, and an equally fine series of clock dials, identified, dated, and described with a competence rare among writers on antiques. Typographically the book is all that could be desired.

The first of the Quaker clockmakers was Abel Cotty, who arrived in Philadelphia in 1682 and was probably the first man to carry on the trade in Pennsylvania. His apprentice and son-in-law, Benjamin Chandlee, continued the business, later removing to Maryland. There and in Virginia succeeding generations of Chandlees were engaged in clockmaking until well into the nineteenth century. To the author, these men are respected ancestors whose lives are worthy of record. To the reader they will be of interest as typical early American mechanics whose skill is demonstrated by an astonishing number of surviving clocks. The imprint of the Historical Society of Pennsylvania on the book is a well-merited acknowledgment of its value as a contribution to an understanding of one aspect of American history.

[2] Consulting Mechanical Engineer, Philadelphia, Pa. Mem. A.S.M.E.

History of Music Boxes

The Curious History of Music Boxes. By Roy Mosoriack. Lightner Publishing Co., Chicago, 1943. Cloth, 8×11 in., 242 pp., illus., $5.

Reviewed by P. R. Hoopes[2]

AUTOMATIC musical instruments have a history of two thousand years of development paralleling to a notable degree the evolution of clockwork. In the seventeenth century the musical clock was introduced in Europe and during the following century many of the more expensive eight-day domestic clocks were equipped with musical attachments. The musical device was an elaboration of the conventional striking mechanism of the timepiece. It consisted of a series of bells, each provided with a separate hammer actuated by pins on the periphery of a rotating cylinder whose velocity was regulated by a fly. Attempts to incorporate this feature into pocket watches led to the use of small vibrating metal reeds in place of bells, the pins on the cylinder acting directly against the ends of the reeds. This is the principle upon which the popular nineteenth-century music boxes were made. It is to a chronology of the latter instruments that "The Curious History of Music Boxes" is confined.

Much of the interest in this book will be found in the illustrations. Forty full-page plates display more than a hundred music boxes, musical watches, and musical automatons, some of them notable examples of the finest design and workmanship. The earliest are musical watches and clocks of French origin. Swiss music-boxes of grandfather's day are well repre-

sented, some of the most elaborate specimens being from the collection of the Edison Institute at Dearborn. The Regina, manufactured in large quantities at Rahway, New Jersey, is shown in both home and barroom models.

In preparing his text the author seems to have depended for information upon recent books, magazine articles, and United States patents from 1869 to 1904. The few pages of historical text are compiled quite uncritically from these sources. A long check list of music-box makers contains the names of the United States patentees and of numerous clock and watchmakers copied from G. H. Baillie's well-known list. A brief bibliography includes several standard modern works on clocks, watches, and automatons but no primary sources. The book concludes with an article by Glenn P. Heckert on repairing music boxes. The reviewer found Mr. Heckert's contribution the most interesting feature of an otherwise remarkably superficial work, a work which is less a history than a compilation of the undigested notes of an enthusiastic amateur.

Books Received in Library

AERODYNAMICS OF THE AEROPLANE. By W. L. Cowley. Ronald Press Co., New York, N. Y., 1944. Cloth, 5 × 8 in., 201 pp., diagrams, charts, tables, $2.25. A British introduction to the subject, intended to provide a background for advanced study. The presentation is unusually clear and simple, with a minimum use of mathematics.

AIRCRAFT SHEET METAL WORK. By C. A. LeMaster. American Technical Society, Chicago, Ill., 1944. Fabrikoid, 6 × 9½ in., 387 pp., illus., diagrams, charts, tables, $3.75. This practical book provides a basic course of instruction for apprentices and other students of aircraft sheet-metal work. The first chapters deal with safety rules, personal and shop-furnished tools, and blueprint reading. The other chapters progress from simple to more complicated processes and operations. Practical projects accompany the chapters dealing with processes in accordance with the emphasis on "how to do it." Two chapters are devoted to the properties of the important metal for this type of work.

AIRPLANE PROPELLER PRINCIPLES. By W. C. Nelson. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1944. Cloth, 5½ × 8½ in., 129 pp., illus., diagrams, charts, tables, $2.50. The aerodynamic, mechanical, and structural principles that must receive consideration in the design of propellers are presented in an elementary course, which is believed sufficient to prepare the student for specialization when need arises.

AMMUNITION, Its History, Development, and Use, 1600 to 1943—.22 BB Cap to 20 mm. Shell. By M. M. Johnson, Jr., and C. T. Haven. William Morrow and Co., New York, N. Y., 1943. Cloth, 6 × 9½ in., 374 pp., illus., diagrams, charts, tables, $5. The development of ammunition is traced from the beginning of the paper musket cartridge to the forms used today. It covers both early and modern pistol and revolver cartridges and all foreign and American sporting cartridges, and discusses the larger type of fixed ammunition now being used in antiaircraft and antitank cannon. Much information is included on defects in cartridges, stoppages, and ballistics.

ANNUAL REPORT ON THE PROGRESS OF RUBBER TECHNOLOGY, volume 6, 1942, edited by T. J. Drakeley; published by W. Heffer & Sons, Ltd., Cambridge, England, for the Institution of the Rubber Industry, London, S.W.1., 1943. Paper, 7½ × 9½ in., 131 pp., diagrams, tables, 10s 6d to nonmembers; 2s 6d to members. This report gives a useful summary of developments in rubber technology during the year 1942 in the form of reviews of each subject. The production of raw rubber, the properties and uses of latex, the chemistry and physics of raw rubber, synthetic rubber, testing and specifications, compounding ingredients, fibers and textiles, and the properties of vulcanized rubber are considered. Other sections deal with tires, belting, hose and tubing, cables and electrical insulation, footwear, mechanical rubber goods, flooring, surgical goods, composites of textiles and rubber, sponge rubber, hard rubber, works processes, and machinery. Each section has a bibliography.

APPLIED SAFETY ENGINEERING. By H. H. Berman and H. W. McCrone. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1943. Cloth, 5½ × 8½ in., 189 pp., diagrams, tables, $2. This textbook places emphasis on the practical use of safety engineering rather than on methods and the reasons for them. After presenting the fundamental requirements for a safety program, the book describes how investigations should be made, how to write safety rules, regulations and messages, how to hold safety conferences, and how to make talks and inspections. Each topic is illustrated by cases and specimens.

AUDELS MARINE ENGINEERS' HAND BOOK, a Practical Treatise for Marine Engineers, all grades, firemen, oilers, and machinists, covering modern marine engineering, including questions and answers. By E. P. Anderson. Theo. Audel & Co., New York, N. Y., 1943. Fabrikoid, 5 × 7 in., 1258 pp., illus., diagrams, charts, tables, $4. This handbook is intended for the marine engineer. It provides information, in the form of questions and answers, upon the construction, operation, and maintenance of ship machinery of all kinds. Those preparing for examinations will find it useful.

AVIATION GASOLINE MANUFACTURE. (Mineral Industries Series.) By M. Van Winkle. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1944. Cloth, 5½ × 8½ in., 275 pp., diagrams, charts, tables, $3. The manufacture of high-antiknock hydrocarbons is described in detail, with particular reference to their application as aviation fuel. Separate chapters deal with the manufacture of their components, the characteristics and performance of the fuels, specifications and test methods. Necessarily recent developments cannot be included, owing to war. The history and development of aviation fuel and its manufacturing processes are included.

BASIC MATHEMATICS FOR WAR AND INDUSTRY. By P. H. Daus, J. M. Gleason, and W. M. Whyburn. The Macmillan Co., New York, N. Y., 1944. Cloth, 5½ × 8½ in., 277 pp., illus., diagrams, charts, tables, $2. A single text which presents selected principles of elementary mathematics in a carefully organized manner is here offered. The text covers the elements of arithmetic, algebra, geometry, plane, and spherical trigonometry.

BELOVED SCIENTIST, Elihu Thomson, a Guiding Spirit of the Electrical Age. By D. O. Woodbury, with a foreword by O. D. Young. McGraw-Hill Book Co., Inc. (Whittlesey House Division), New York, N. Y., 1944, Cloth, 6 × 9½ in., 358 pp., illus., $3.50. In this biography the versatility of Elihu Thomson is effectively demonstrated. As a pure scientist and as a practical engineer, his talents were directed along many lines, although his most noteworthy achievements were in the field of electricity. As businessman, teacher, or administrator he was in the front rank. The author has developed a history of the electrical industry and built it around the figure of Elihu Thomson and his brilliant contemporaries.

CAR BUILDERS' CYCLOPEDIA of American Practice. Sixteenth edition, 1943. Compiled and edited for the Association of American Railroads, Mechanical Division; edited by R. V. Wright, R. C. Augur, and others; Simmons-Boardman Publishing Corporation, New York, N. Y., 1943. Fabrikoid, 8½ × 12 in., 1324 pp., illus., diagrams, charts, tables, $5. The new edition of this well-known reference book follows the style of its predecessor, with some improvements in form and with better indexes. It again brings up to date the record of American car designs and car equipment.

CIVIL DEFENCE TRAINING MANUAL No. 4—INCIDENT CONTROL. First edition, His Majesty's Stationery Office, London, England, 1943. Paper, 6 × 9½ in., 74 pp., diagrams, tables, 9d. Obtainable from British Information Services, New York, N. Y., $0.25. This manual contains specific directions for organizing and co-ordinating the activities of the services who must deal with the damages caused by air raids. Plans are given for dealing with fires, casualties, property damage, etc.

COMPLEX VARIABLE AND OPERATIONAL CALCULUS WITH TECHNICAL APPLICATIONS. By N. W. McLachlan. The Macmillan Co., New York, N. Y., The University Press, Cambridge, England, 1942. Cloth, 5½ × 8½ in., 355 pp., diagrams, charts, tables, $4.75. A modern treatment of the operational method is offered in this book, with illustrations of its application to problems in radio, television, heat transmission, electrical circuits, and other technological subjects. The operational procedure advocated is believed to offer advantages over other methods in speed and ease. The book is intended primarily for engineers using mathematics in solving technical problems.

DIESEL LOCOMOTIVES—Electrical Equipment. By J. Draney. American Technical Society, Chicago, Ill., 1944. Cloth, 5½ × 8½ in., 388 pp., illus., diagrams, charts, tables, $3.75. A simple, practical text on the operation and maintenance of the electrical equipment of Diesel locomotives. The equipment of the Baldwin-Westinghouse, Electro-Motive, and Alco-G.E. locomotives is described in detail.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Harrison W. Craver, Director, Engineering Societies Library, 29 West 39th St., New York, N. Y.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Plans Well Advanced for A.S.M.E. 1944 Semi-Annual Meeting at Pittsburgh, June 19–22

THE various local committees handling the arrangements for the coming A.S.M.E. Semi-Annual Meeting to be held at the William Penn Hotel, June 19 to 22, 1944, are looking forward eagerly to serving as hosts to A.S.M.E. guests and their friends who contemplate visiting this vital industrial city. Pittsburgh throbs with industry. Its strength and power rest on fuels and metals with steel and coal basic in this area. These raw materials, supplying the heavy industries, set the pattern of our efforts in war and peace for industry throughout the country.

It is but natural, therefore, that the program of this A.S.M.E. convention should stress railroads, fuels, steel, metals, processes, tools, and management.

Nor is "utility" the only attraction of Pittsburgh. The city abounds with historical interest, and relics of the French and Indian War and early explorations of the country are still in existence.

Make Your Reservations Now!

Although full details of the program are not yet decided, a sufficient outline is available to enable members to confirm their decisions as to the value and desirability of attending the sessions at Pittsburgh. Those members planning the trip, should make reservations for their travel arrangements and their accommodations at the William Penn Hotel in order to avoid disappointment. The Pittsburgh Convention Bureau has also arranged for A.S.M.E. accommodations at the Roosevelt, Keystone, Henry, and Fort Pitt Hotels within walking distance of headquarters. Mention the A.S.M.E. Semi-Annual Meeting when you write. Travel at the present time needs to be planned well in advance.

Total of 27 Sessions Planned

Because of the generous number of papers planned, there will be a total of twenty-seven sessions held concurrently both morning and afternoon.

Aviation is once again to the fore in the comprehensiveness of the subjects to be discussed, which range through applied mechanics, metals engineering, rubber and plastics, to production and instruments.

Education is feeling the impact of the war, and training of the engineer must be considered in the light of modern experience. Sessions have been planned for this subject.

As fuels are a vital economic factor both in the war effort and in the Pittsburgh area, two sessions have been planned.

Closely associated with the creation of heat is its transfer and absorption. A couple of sessions are contemplated by the Heat Transfer Division to deal with this subject.

The subject of hydraulics is not being neglected as two sessions are planned.

All modern processes call for close regulation and intimate knowledge of the progress of the operations, therefore it is but natural that industrial instruments and regulators will be considered. Two sessions are planned.

Modern management is to be considered in two sessions that will study the philosophy, techniques, and incentives applicable to the science of management.

Materials-handling problems will not be neglected as two sessions are contemplated.

The Metals Engineering Division will hold one session on cold working and controlled atmospheres and will also collaborate with the Railroad Division in a session studying light metals and ferrous metals.

The Railroad Division is also planning an evening session with J. J. Pelley, president of the Association of American Railroads, as the speaker.

New concepts of power-plant design will feature two sessions of the Power Division.

The Process Industries Division will hold one session on the subject of "Drying."

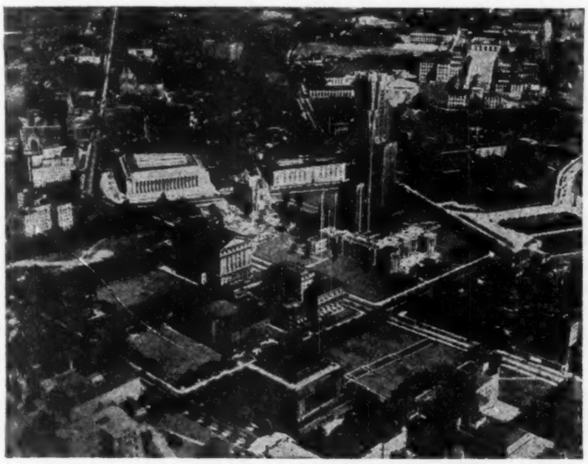
The Production Engineering Division will also hold two sessions on subjects of interest.

Lubrication will be the subject of one session by the Research Committee.

Registration Fee for Non-Members at 1944 Semi-Annual Meeting

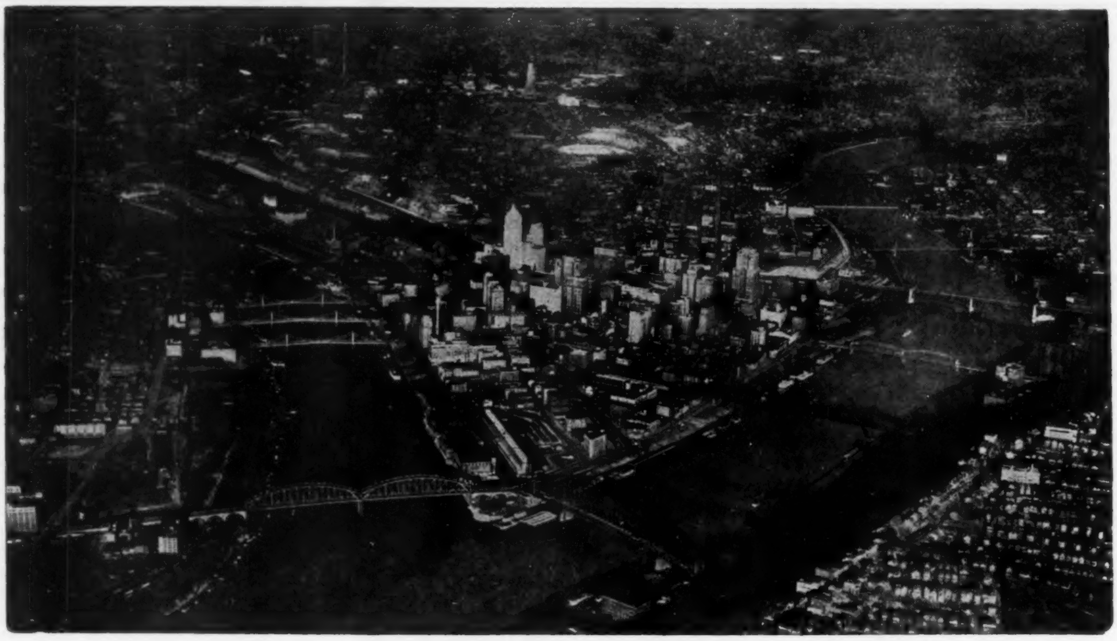
There will be a registration fee of $2 for nonmembers attending the 1944 A.S.M.E. Semi-Annual Meeting at Pittsburgh, Pa., June 19–22, 1944. For nonmembers wishing to attend just one session the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests may avoid this fee by writing to the Secretary of the Society before June 9 asking for a guest-attendance card for the Spring Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member.*



UNIVERSITY OF PITTSBURGH

(A view of the Mellon "Temple of Science," internationally famous scientific laboratory, across the Cathedral of Learning campus at the University of Pittsburgh, showing a wing of the world-famous Cathedral and the Heinz Memorial Chapel. The world's tallest educational building, the Cathedral of Learning, dominates this entire city square of fourteen acres. Surrounding the Cathedral, the Heinz Chapel, and the Stephen Collins Foster Memorial Shrine are terraced lawns of rare beauty. A variety of trees including magnolia, pin and red oaks, elm, copper beach, yews, dogwood, hawthorne, ginkgo, and cornelian cherry makes this "lower campus" a place of rare beauty in the Oakland section of the city.)



THE HISTORICAL POINT, PITTSBURGH

(Here at the confluence of the Allegheny and Monongahela, where starts the mighty Ohio on its trek south, is the apex of the famous "Golden Triangle." Rich in historic interest and the location of the original Fort Duquesne, there still stands the Block House which is all that remains of this early defensive structure. From the point, on a perfect triangle, stretch the buildings and businesses of the great "City of Miracles." Home offices of some of the largest industries in the world are located in this district and here decisions are made which affect the world. United States Engineers reported recently that these three rivers carry more actual freight tonnage than goes through the Panama and Suez Canals combined.)

Luncheons and Dinners

Various luncheons and dinners are being planned for the different groups and although these are not finally decided upon, some of the tentative arrangements are as follows: Management Division: luncheon, Discussion "Conversion From Wartime to Peacetime." Railroad Division: dinner.

The A.S.M.E. Semi-Annual dinner, with a nationally known speaker, will be held on Wednesday, June 21. Both women and men are welcome and in view of war conditions formal attire is not necessary.

Women Cordially Invited

The women will receive a cordial welcome to Pittsburgh and they may be assured that every effort is being made to provide a generous selection of events that will satisfy all tastes. Entertainment has been provided for all four days of the convention. At least four or five inspection trips are being planned for members desiring to make them and in order to avoid inconvenience and embarrassment all individuals contemplating such visits should provide themselves with satisfactory credentials as to citizenship.

Official Notice

A.S.M.E. Business Meeting

THE Semi-Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held Monday afternoon, June 19, 1944, at 4:00 p.m. at the Hotel William Penn, Pittsburgh, Pa., as a part of the Semi-Annual Meeting of the Society.

(*Signed*) C. E. DAVIES
Secretary

A.S.M.E. Aviation Division to Hold Huge Meeting at Los Angeles, June 5–9

ONE of the largest annual meetings ever to be held by the Aviation Division of The American Society of Mechanical Engineers is scheduled for June 5 to 9 at the Los Angeles Campus of the University of California.

Sessions are planned on production, heat transfer, applied mechanics, metals engineering, hydraulics, rubber and plastics, and education—all in respect to the field of aviation. Many of the foremost engineers, scientists, and educators in these fields are to present talks or papers at these sessions which will undoubtedly lead to spirited discussion on these of-the-moment topics.

The preliminary program follows:

MONDAY, JUNE 5

7 p.m.

Aviation—Production

Panel Discussion: Master Tooling

Chairman: T. A. Watson, University of California, E.S.M.W.T., Los Angeles, Calif.

7 p.m.

Aviation—Heat Transfer

Chairman: L. M. K. Boelter, department of mechanical engineering, University of California, Berkeley, Calif.

The Weight Economy of Extended Surface Exchanges, by B. L. Messanger, Lockheed Aircraft Corporation, Burbank, Calif.

Graphical Solution of Windshield Heat De-Icing Problems, by H. H. Hangar, air-conditioning engineer, Douglas Aircraft Company, Inc., Santa Monica, Calif.

Shielded Thermocouple Arrangements, by N. Tifford, aeronautical engineer, Lockheed Aircraft Corporation, Burbank, Calif.

7 p.m.

Aviation—Applied Mechanics

Chairman: Louis G. Dunn, California Institute of Technology, Pasadena, Calif.

Presentation of Centrifugal Compressor Performance in Terms of Nondimensional Relationship, by Bruce E. Del Mar, project engineer, Douglas Aircraft Company, Inc., Santa Monica, Calif.

The Significance of Weight, by Martin Boe, section head, weight group, Consolidated-Vultee Aircraft Corporation, Vultee Field, Downey, Calif.

Some Preliminary Investigations Concerning the Effect of Stress Concentration on Fatigue Life, by D. W. Drake, research engineer, Lockheed Aircraft Corporation, Burbank Calif.

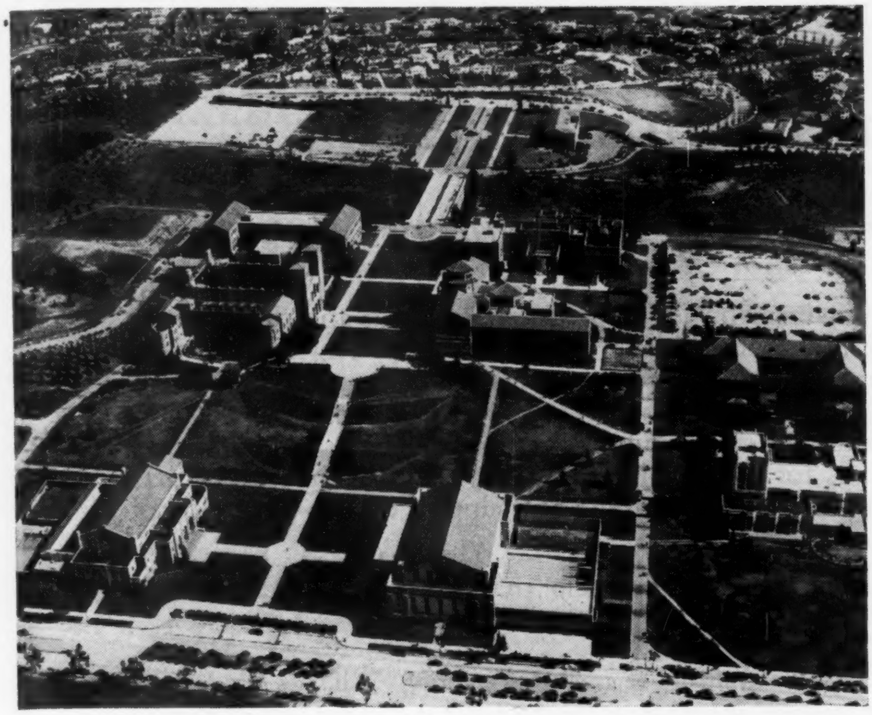
TUESDAY, JUNE 6

7 p.m.

Aviation—Production

Panel Discussion: Contour Engineering

(*Program continued on page 341*)



AIR VIEW OF LOS ANGELES CAMPUS OF THE UNIVERSITY OF CALIFORNIA

Chairman: John C. Dillon, area supervisor, E.S.M.W.T., University of California, Los Angeles, Calif.

7 p.m.

Aviation—Metals Engineering

The Effect of Shape on the Formability of Deep Drawn Metal Parts, by William A. Box and William Schroder, research engineers, Lockheed Aircraft Corporation, Burbank, Calif.

Metlbond—a Metal Adhesive for Aircraft, by G. C. Havens, design staff engineer, Consolidated-Vultee Aircraft Corporation, San Diego, Calif.

General Aviation Processing Problems as Applied to Metals, by W. E. Donaldson, process section supervisor, Lockheed Aircraft Corporation, Burbank, Calif.

7 p.m.

Aviation—Applied Mechanics

Fundamentals of Shear Lag Design, by J. E. Wignot, stress engineer, Lockheed Aircraft Corporation, Burbank, Calif.

A New Method of Calculating Natural Modes of Coupled Bending-Torsion Vibration of Beams, by N. O. Myklestad, California Institute of Technology, Pasadena, Calif.

Design of Stiffened Plane Sheet Webs, by C. R. Tuttle, stress engineer, Lockheed Aircraft Corporation, Burbank, Calif.

WEDNESDAY, JUNE 7

7 p.m.

Aviation—Production

Panel Discussion: Production Problems

7 p.m.

Aviation—Metals Engineering

Metals Engineering, by D. H. Gastor, design engineer, Consolidated-Vultee Aircraft Corporation, San Diego, Calif.

Recent Developments in the Use of Metals in Aircraft Structures, by L. D. Bonham and Paul P. Mozley, Lockheed Aircraft Corporation, Burbank, Calif.

Efficiency of Flash Welding, by M. A. Melcon, stress engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Problems Associated With Flash Welding, by F. C. Pipher, senior welding engineer, Lockheed Aircraft Corporation, Burbank, Calif.

7 p.m.

Aviation—Hydraulics

Chairman: R. G. Falsom, E.S.M.W.T., University of California, Los Angeles, California

Designing the Hydraulic System of a Simple Engine, Single Place, Combat Airplane, by E. Kanarik and J. Jerome, hydraulic design staff engineers, Consolidated-Vultee Aircraft Corporation, Vultee Field, Downey, Calif.

Hydraulics in Aircraft, by Ralph Middleton, hydraulics engineer, Aircraft Accessories Corporation, Burbank, Calif.

Trends in Aircraft Electrical Systems, by C. J. Bretwiesser, electrical design staff engineer, Consolidated-Vultee Aircraft Corporation, San Diego, Calif.

THURSDAY, JUNE 8

7 p.m.

Aviation—Production Engineering

High-Speed Milling, by Hans Ernst, research director, Cincinnati Milling Machine Company, Cincinnati, Ohio

High-Speed Milling of Spar Caps, by N. A. Lombard, superintendent of spar-cap tool engineering, Douglas Aircraft Company, Inc., Santa Monica, Calif.

7 p.m.

Aviation—Rubber and Plastics

Rubber Specifications for the Aircraft Industry, by Raymond B. Stringfield, Consolidated-Vultee Aircraft Corporation, Vultee Field, Downey, Calif.

Fatigue Testing Machines and Methods, by H. W. Foster and Victor Seliger, research engineers, Lockheed Aircraft Corporation, Burbank, Calif.

Evaluation of Elastic Limits of Plastics, by John Delmonte, technical director, Plastics Industries, Technological Institute, Los Angeles, Calif.

Delignified Wood, by Foster Luce, research engineer, Westcraft Incorporated, Los Angeles, Calif.

7 p.m.

Aviation—Education

Production Design Education, by W. H. Arata, Jr., production design engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Insuring Effectiveness in Engineering Training, by R. L. Maw, Co-Ordinator of Engineering, Consolidated-Vultee Aircraft Corporation, San Diego, Calif.

Papers on "Forging of Steel Shells" Published in Limited Edition

PAPERS on the "Forging of Steel Shells" presented at the 1943 Annual Meeting of the A.S.M.E. have been published for reference purposes in a limited edition for binding with the 1944 volume of the Transactions of the Society. There are, however, a small number of these pamphlets available for sale at seventy-five cents a copy.

This procedure was followed at the request of the Publications Committee of the Society who felt that the acute shortage of paper warranted such action when articles are of immediate interest to relatively few.

Bulletin on Unit Loads Available

A BULLETIN entitled "Unit Loads, Their Handling, Shipment, Storage," has been published by The Industrial Truck Statistical Association, 208 South La Salle Street, Chicago 4, Ill., and is available upon request.

Among the topics covered are: Types of unit-load handling equipment available; combination systems; pallets, their design and construction; the assembly of unit loads; loading and unloading cars; warehousing and stevedoring. The latter portion of the bulletin is devoted to case studies which show what has actually been accomplished, in the way of savings, in the handling and packing of diversified types of products.

President Gates Honored

ON February 27, Robert M. Gates, president A.S.M.E., was honored by his Alma Mater, Purdue University, by the conferring on him the degree of Doctor of Engineering. The citation read: "Robert McFarland Gates, man of talent and of devotion to duty; acclaimed leader of the profession of engineering."

President's Page

The Training and Retraining of Engineers

AMERICAN engineering education is in such capable hands and the faculties of our engineering schools are so intimately associated with the activities of the A.S.M.E. that we accept their leadership and give them our support in the adjustments required in training engineers for the changing needs of society. It is nevertheless important that our members inform themselves of the changing and expanding demands for engineering training, in order that the efforts being made to meet them may have the intelligent support and co-operation of our profession generally.

Let us consider some aspects of the problem that are assuming prime importance.

1 What standards of selection can and should be applied to entering candidates for an engineering degree, or what other measures should be taken, to avoid the 50 per cent average of "scholastic failures" among admitted students? This enormous waste of educational facilities and educational effort seems avoidable; it would certainly be intolerable in our use of materials.

2 Creative imagination, instinct for leadership, and adaptability to co-operative effort are qualities that need not only to be discovered but also to be encouraged and exercised in the course of engineering education, if our profession is to be equipped for maximum service. Is there danger that these be buried under the traditional curricula of high schools and colleges —to emerge late, if at all, in an engineering career?

3 Since the world is demanding from engineers, as from industrial management, more responsibility for the social changes their works bring about, is the engineering curriculum providing adequate preparation for these students to meet these responsibilities?

4 Are adequate facilities provided for continued education of engineering graduates so that they may keep abreast of the rapid advances of science and technology and with new demands for engineering service?

5 Postwar America and the rest of the postwar world will need a multitude of technicians who need not have a complete professional engineering education. The armed services will furnish many of them, but they will need additional training. The high schools will turn out still more. Do we have throughout the country adequate facilities for such technical training—in vocational schools, junior colleges, or elsewhere? What can we do to get them provided? What recognition should be given graduates for such training?

6 Do our elementary schools and high schools furnish the intellectual discipline and fundamental skills that are needed as preparation for the changing type of education being planned in the colleges and engineering schools?

Our engineering schools and educational committees are grappling with these problems. Our Society owes them its interest and co-operation.

Your suggestions and comments are earnestly requested.

(*Signed*) R. M. Gates, *President*, A.S.M.E.

Industrial Possibilities of South Reviewed at 1944 A.S.M.E. Spring Meeting at Birmingham, Ala., April 3–5

Group X Student Conference Meets Jointly With Parent Society

THE work of the mechanical engineer in the war and in the peace to follow, with particular emphasis on opportunities for industry and engineering in the Southern States, was reviewed in the papers and addresses delivered at the 1944 Spring Meeting of The American Society of Mechanical Engineers, held at the Tutweiler Hotel, Birmingham, Ala., April 3–5. The attendance was 500 members and guests.

Coincident with the Spring Meeting was held the Group X student meeting of A.S.M.E. Student Branches in the Southeastern area. At this student meeting, which was presided over by Charles Bush, of the University of Louisville, and at which about 100 students from 8 student branches were present, ten technical papers were presented in competition for 5 cash awards. Announcement of the names of winners of the awards was made at the Spring Meeting banquet on April 4.

Committee Meetings Precede Technical Sessions

Although the 1943 Spring Meeting opened publicly with a luncheon on Monday, April 3, a meeting of several members of the Council and the Executive Committee, with President Gates in the chair, preceded it in the morning. The Committee on Local Sections met on Sunday morning and continued through Sunday evening. Under the direction of J. W. Shields, secretary of the A.S.M.E. Boiler Code Committee, an informal conference on the Boiler Code was held on Monday morning, in which all persons interested in the work of the Committee were invited to participate.

Fritsche Speaks on Industry in South

Joseph W. Eshelman, vice-president of the Society and member of the Local Executive Committee, presided at the opening luncheon. Mr. Eshelman introduced W. Cooper Green, president of the Birmingham City Commission, who delivered the address of welcome to the more than 200 members and guests in attendance.

Speaking on new frontiers of the South, C. B. Fritsche, vice-president, Reihhold Chemicals, Inc., Tuscaloosa, Ala., painted a broad picture of the present and potential opportunities for engineering, industry, and agriculture in the South. With abundant resources in young people, cheap power, and raw materials, the future was bright with promise, he asserted. The chemical industry in the South, he said, had been tremendously accelerated by the war program. The trend of this industry toward the South would continue as long as the basic raw materials were available and as long as local state governments created and maintained a healthy climate for industrial expansion.

After reviewing the status in the South, of the magnesium, aluminum, and plastics industries, Mr. Fritsche directed attention to the chemurgic industries and spoke briefly of six of them; alcohol plants utilizing starch and sugar crops; starch plants based on the southern sweet potato; tung-oil plants; kraft and newsprint mills; wood-plastics plants; and the heavy chemical industries. These six groups of industries alone, he said, should require the cultivation of thirty million acres.

In conclusion he said that men of science were growing indignant over the perversion of their discoveries to the slaughter of human beings. Men of science in every nation would soon be asking the question of men of state: "Why go to war for that which can be obtained without war?" Perhaps, he said, the world needed to change doctors, from doctors of law to doctors of science, in seeking a new enlightened leadership.

Following Mr. Fritsche's address Mr. Eshelman introduced Mr. Erskine Ramsay, distinguished citizen and industrialist of Birmingham, who spoke briefly and presented to President Gates and Secretary Davies copies of his biography, written by James Saxon Childers.

WELL-KNOWN A.S.M.E. MEMBERS AT THE BIRMINGHAM SPRING MEETING

(*Left to right:* Joseph W. Eshelman, vice-president, A.S.M.E.; H. G. Mouat, chairman of the Birmingham Section; R. M. Gates, President, A.S.M.E.; and Jonathan A. Noyes, Vice-President, A.S.M.E.)

Management Subjects Under Discussion

The two technical sessions on Monday afternoon which followed the opening luncheon were sponsored by the Management Division and the Committee on Education and Training for the Industries.

James M. Barry, member A.S.M.E., and vice-president and general manager, Alabama Power Company, Birmingham, Ala., presided at the Management Session and L. B. Bell served as recorder. Two papers were presented and discussed: "Management Adjustments From War to Peace," by Dillard B. Lasseter, regional director, War Manpower Commission, Atlanta, Ga.; and "The Southern Economy and Manpower Utilization," by Roscoe Arant, regional consultant, U. S. Department of Commerce, Atlanta, Ga.

Talk on Specialized and Postcollegiate Education

Under the chairmanship of Eugene M. O'Brien, former vice-president of the Society, of Atlanta, Ga., and with Joshua E. Hannum, dean of engineering, Alabama Polytechnic Institute, Auburn, Ala., as recorder, the Committee on Education and Training for the Industries offered two papers on different aspects of the industrial educational problem. Guy Cowing, assistant director, General Motors Institute of Technology, Flint, Mich., described and explained the design and development of a training program. This was followed by a sound film illustrating the importance of technical personnel to the effective prosecution of the War.

AT THE FIRST MANAGEMENT SESSION OF THE SPRING MEETING

(*Left to right:* C. B. Fritsche, vice-president, Reichhold Chemicals, Inc., Tuscaloosa, Ala., and speaker at the Monday Luncheon; Roscoe Arant, regional consultant, U. S. Department of Commerce, author of "The Southern Economy and Manpower Utilization;" Dillard B. Lasseter, regional director, War Manpower Commission, Atlanta, Ga., author of the paper "Manpower Adjustments From War to Peace;" and James M. Barry, vice-president and general manager of the Alabama Power Co., and chairman of the session.)

A. R. Stevenson, Jr., a manager of the Society and staff assistant to the vice-presidents in charge of engineering, General Electric Company, Schenectady, N. Y., spoke on the responsibility of industry for postcollegiate education with a brief account of the educational program of the General Electric Company in this field.

Hydro and Steam Plants Discussed

The Aviation, Fuels, Power, and Hydraulic Divisions were responsible for the three technical sessions held on Monday evening.

At the power-hydraulic session, held in the auditorium of the Alabama Power Company, J. A. Keith, member A.S.M.E., of the Kansas City Power and Light Company, Kansas City, Mo., was chairman and Prof. S. R. Beitler, member A.S.M.E., of The Ohio State University, was recorder. Two papers were presented: "The Co-Ordinated Operation of Hydro and Steam Capacity in Electric Power Systems," by G. W. Spaulding, vice-president, Pennsylvania Water and Power Company, Baltimore, Md.; and "Range of Operation of Steam Plants in a Combined System of Steam and Hydro," by A. T. Hutchins, production consultant, and Howard Duryea, co-ordinator of system power supply, Commonwealth and Southern Corporation, of New York, Southern Division, Birmingham, Ala.

Films Show Aero-Engine Manufacture

John E. Younger, secretary, A.S.M.E. Aviation Division, of the University of Maryland, College Pt., Md., presided at the Aviation session, and J. W. Shields, secretary, A.S.M.E. Boiler Code Committee, acted as recorder. A paper on postwar transport airplanes and airports, prepared by Charles Froesch, chief engineer, Eastern Air Lines, was read in his absence by Walter Prokosch.

At the same session H. E. Linsley, public-relations director, Wright Aeronautical Corporation, Paterson, N. J., told about aircraft engines on the production line. His paper was followed by the showing of numerous lantern slides which contrasted machining operations before and after pressure of war requirements made quantity production on automatic machines a necessity. Following the slides was a showing of the sound film, "Power by Wright." This film was shown a second time on Tuesday afternoon.

Combustion of Fuels Illustrated

The Fuels Session was conducted by J. W. Eshelman, with L. A. Shipman serving as recorder. T. C. Cheasley, supervisory engineer, National Fuel Efficiency Section, Bureau of Mines, Washington, D. C., presented a progress report on the National Fuel Efficiency Program of the Bureau of Mines, which was followed by a British film showing firing methods by hand and by stoker and emphasizing fuel economy.

A paper, "A Study of Stoker Fuel Beds," was presented by Otto de Lorenzi, director of education, Combustion Engineering Company, Inc., New York, N. Y. Mr. de Lorenzi's paper was illustrated with colored motion pictures of fuel beds which had been "speeded up" so that several hours of operation were observable in the space of a couple of minutes.

Shell and Centrifugal-Casting Plants Visited

Tuesday morning was devoted to two plant trips with transportation by private cars generously made possible by members of the Birmingham Section. The motorcade went first to the Rheem Manufacturing Company where the forging and machining of steel shell and the manufacture of cartridge cases were observed.

At the ACIPCO plant of the American Cast Iron Pipe Company, opportunity was afforded of seeing both the static and centrifugal casting of iron and steel. The visit proved to be an excellent introduction to the paper on centrifugal casting presented on Wednesday afternoon.

Helicopter Development Reviewed

Three sessions, under the auspices of the Aviation, Power, and Management Divisions, comprised the Tuesday afternoon program.

At the Aviation session Alan Y. Pope, Daniel Guggenheim School of Aeronautics, Georgia School of Technology, Atlanta, Ga., served as chairman and Professor Younger as recorder.

The session commenced with a paper on airport development by Charles M. Johnson, district airport engineer, Birmingham, Ala., and was followed by a historical review of helicopter development by Donnell W. Dutton, head of Guggenheim School of Aeronautics, Georgia School of Technology, Atlanta, Ga. Professor Dutton's paper was generously illustrated with pictures and sketches of the principal attempts at helicopter design from the days of Leonardo da Vinci to the successful Focke-Wulf and Sikorsky helicopters. Through the courtesy of Igor Sikorsky a sound color film showing the Sikorsky helicopter was run.

Two Papers on Steam Power

At the Alabama Power Auditorium, the Power session was held with Roscoe W. Morton, of Knoxville, Tenn., a manager of the Society, as chairman and C. W. Kramer, as recorder.

M. K. Bryan and R. T. Mathews, of Chas. T. Main, Inc., Boston, Mass., presented a paper on the performance of the Watts Bar steam station. "Pressure and Temperature Trends," was the title of the second paper, of which E. C. Gaston, Commonwealth and Southern Corporation, Birmingham, Ala., was the author.

Work Simplification in Steel Mills

John M. Gallalee, member A.S.M.E., professor of mechanical engineering, University of Alabama, University, Ala., presided at the Management session and Dean Hannum acted as recorder. The paper, "Introduction of Work Simplification in the Steel Industry," was presented by A. H. Roosma, assistant manager, Southern District, Republic Steel Corporation, Gadsden, Ala.

General Barnes Addresses Banquet

The ballroom of the Hotel Tutweiler was crowded with 444 members and guests at the banquet on Tuesday evening. Harry G. Mouat, general chairman of the Birmingham Committee presided and expressed thanks and appreciation to everyone who had contributed to the success of the 1944 Spring Meeting.

Dr. John M. Gallalee, of the University of Alabama, acted as toastmaster. He introduced the President of the Society, Robert M. Gates, recently honored by Purdue University with the degree of Doctor of Engineering. Mr. Gates' address, which is published in this issue, was entitled, "Engineers and Postwar Industry."

Following Mr. Gates, Major General G. M. Barnes, Chief, Technical Division, Office of the Chief of Ordnance, Washington, D. C., spoke on "Keying Research to Battle Problems."

General Barnes, who is responsible for the research and development carried on by the Ordnance Department, spoke of the great need for engineering and technical service in modern warfare. He commented on several types of weapons and equipment developed for the United States military forces and compared them with similar weapons and equipment used by the Axis powers, many examples of which have been captured and studied at Aberdeen Proving Ground. His paper will be published in a later issue of Mechanical Engineering.

Winners of Student Awards Announced

The winners of papers contest of Group X Student Branch Conference were announced by R. T. Reece of the Committee on Relations With Colleges, who called to the head table the five recipients of awards. The first prize was awarded to Lewis R. Twitchell, of the University of Florida, for his paper, "Electrolytic Polishing of Metal." The other recipients, in the order of the selection made by the judges were: Melvin T. Sturm, of the University of Tennessee; John Cochrane, of Tulane University; David Kling, of the University of Louisville; and Gerard R. Pucci, of Virginia Polytechnic Institute. President Gates presented the awards.

Fuels Session Attracts Many

The concluding technical sessions were held on Wednesday morning and afternoon. The three morning sessions were under the auspices of the Fuels Division, the Industrial Instruments and Regulators Division, and the Research Committee on Metal Cutting Data and Bibliography.

At the Fuels Session the chairman was A. R. Mumford, Jr., member A.S.M.E., Research Department, Combustion Engineering Company, Inc., New York, N. Y., and the recorder was J. W. Shields. The session was held in the Alabama Power Auditorium.

Lieut. Harold G. Elrod, Jr., Department of Marine Engineering, U. S. Naval Academy, Annapolis, Md., presented a paper entitled, "An Ejector Theory and Its Applications." This was followed by a panel discussion on maintenance of coal pulverizers in which the following were members of the panel: George R. Ozley, chief engineer, Alabama By-Products Corporation; J. L. Adamson, general master mechanic, Sloss-Sheffield Steel and Iron Company; H. T. White, superintendent, Mechanical and Electrical Department, Fairfield Works, Tennessee Coal, Iron and Railroad Company; O. C. Hassell, master mechanic of Blast-Furnace Division, Ensley plant, T.C.I. & R.R. Co.; and W. C. Beattie, chief engineer, Waterside Station, Consolidated Edison Company of New York, Inc.

Industrial Instruments and Regulators

Prof. W. Trinks, member A.S.M.E., Pittsburgh, Pa., acted as chairman of the Instruments session and E. J. Kohn as recorder. Two papers were presented, "Ratio and Multiple Fuel Controls in the Steel Industry," by H. Ziebolz, chief engineer and vice-president, Askania Regulator Company; and "An Electrical-Analogy Method of Determining the Effect of Dead Time in Automatic Control," by D. P. Eckman, development engineer, and W. H. Wannamaker, development engineer, Brown Instrument Company.

SPEAKERS AT THE SPRING MEETING BANQUET

(Robert M. Gates, President, A.S.M.E., and Major General G. M. Barnes, U. S. Army, Chief of the Technical Division, Office of the Chief of Ordnance.)

Three Methods of Treating Cutting Tools Presented

At the session on the cutting of metals, M. E. Lange, Warner and Swasey Company, Cleveland, Ohio, acted as chairman and F. W. Lucht, Carboloy Company, served as recorder. Three papers on different methods of improving cutting performance were presented. Axel Lundbye, chief engineer, The Crowell-Collier Publishing Company, Springfield, Ohio, told about the performance of cutting tools chromium-plated by the Lundbye process; J. G. Morrison, metallurgist, Landis Machine Company, Waynesboro, Pa., described the nitriding of high-speed-steel tools; and G. B. Berlien, chief metallurgist, Lindberg Steel Treating Company, Chicago, Ill., spoke on subzero refrigeration applied to tool steels.

Polglaze Talks on Conservation

Paul Wright, former member of the A.S.M.E. Council, of Birmingham, Ala., presided at the Wednesday luncheon attended by about 150 members and guests. After introducing the persons at the speakers' table and many in the audience, Mr. Wright called upon Eugene M. O'Brien to present the speaker, R. A. Polglaze, of Birmingham, Ala.

Mr. Polglaze's address was entitled "Domestic Water Supplies, Their Source and Conservation." The source of domestic water supply, Mr. Polglaze pointed out, was rainfall, of which the state of Alabama had a yearly average of 54 inches. Such a rainfall, he said, was adequate, but the adequacy depended also on conservation because excessive runoff would result if the natural conditions of vegetation, swampland, and the like, were greatly disturbed. Although at one time Alabama had many streams that ran continuously, at present, because of the interference of the natural balance by man, several of these streams and numerous springs and wells had become practically dry at certain times of the year.

The problem of conservation of domestic water supply, he pointed out, was national as well as local. Factors involved in a conservation program were reforestation, increase of cultivated cover, and the retention of swampland. Conservation and fire-control programs were called for to renew and to prevent further loss of forest cover. Conservation, he said, was a long-range program but it called for immediate action. In any conservation program the engineer played an important role. Public and private conservation agencies were in need of the co-operation of the public, he concluded.

Centrifugal Casting of Steel Described

Sessions on metals engineering, heat transfer, and centrifugal pumps were held on Wednesday afternoon.

At the session under the auspices of the Metals Engineering Division, held in the Alabama Power Auditorium, the co-chairmen were Lieut. Col. John E. Getzen, member A.S.M.E., Ordnance Department, Birmingham Ordnance District; and Richard A. North, member A.S.M.E., vice-president, Farrel-Birmingham Company, Ansonia, Conn.; and the recorders were W. Joe Moore and H. S. Kent.

Owing to the absence of E. V. Cramp, president, E. V. Cramp and Associates, Atlanta, Ga., his paper, "Description of Manufacture of Heavy Cast-Steel Anchor Chain," was read by Dr. J. T. McKenzie, chief metallurgist, ACIPCO. S. D. Moxley, member A.S.M.E., chief engineer, ACIPCO, Birmingham, Ala., presented a paper on the centrifugal casting of steel. Mr. Moxley described and discussed the true centrifugal, semicentrifugal, and centrifuging methods of centrifugal casting and showed many slides illustrating methods and products.

Heat-Transfer Session

R. L. Sweigert, member A.S.M.E., director, general engineering, Georgia School of Technology, Atlanta, Ga., acted as chairman of the session under the auspices of the Heat Transfer Division. The recorder was Robert L. Allen. Two papers were presented: "The Influence of Through Metal on the Heat Loss of Insulated Walls," by Victor Paschkis and M. P. Heisler, of Columbia University,

New York, N. Y.; and "Temperature Distribution Within Boiler Tubing Under Oblique Radiation," by Lieut. Comdr. W. S. Kimball, Department of Marine Engineering, U. S. Naval Academy, Annapolis, Md.

Centrifugal Pumps Discussed

At the session on centrifugal pumps, under the auspices of the Hydraulic Division, George R. Rich, member A.S.M.E., chief design engineer, T.V.A., Knoxville, Tenn., acted as chairman, and Geo. I. Bentley served as recorder. Igor J. Karassik, application engineer, Worthington Pump and Machinery Corporation, discussed certain aspects of high-pressure centrifugal pumping cycles; and J. D. Scoville, assistant chief engineer, S. Morgan Smith Company, York, Pa., presented a paper entitled, "Adjustable-Blade Pump Installations for Drydock Unwatering."

Birmingham Committees Excellent Hosts

Too much praise cannot be accorded members of the Birmingham Section and the chairmen of the numerous committees, and the men who served on them, for the many days of hard work which made the meeting an occasion long to be remembered by visitors.

The local executive committee was headed by Harry G. Mouat. Serving with him were Jos. W. Eshelman, Paul Wright, Dr. John M. Gallalee, S. D. Moxley, Lieut. Col. John E. Getzen, T. M. Francis, Abbott H. Blair, E. J. Kohn, Joseph G. Reid, and Dean J. E. Hannum.

The finance committee consisted of two cochairmen, John J. Greagan and Paul Wright, and Joseph G. Reid.

Joseph W. Eshelman headed the entertainment committee, and with him served S. D. Moxley and J. B. Bell.

Capt. C. F. von Herrmann, Jr., served with distinction as chairman of the technical-events committee.

Chairmen of the printing and signs committee and the hotel committee were Fred E. Vann and Geo. L. Bentley.

The joint committee on reception and plant trips was headed by Chas. B. Davis. Associated with him were John B. Emory, Ray N. Ruiter, J. B. Bell, and Joseph G. Reid.

Information and registration were under the supervision of Lieut. Col. H. L. Freeman and a committee consisting of D. H. Guldberg, Robert D. O'Neil, Fred E. Vann, Alphonso Taurman, and George W. Rust.

John J. Greagan was in charge of the ladies' committee.

Polish Engineering Review Published in Canada

THE first issue of *Polish Engineering Review*, official organ of the Association of Polish Engineers in Canada, has been received.

In the first issue are messages of greeting from The Engineering Institute of Canada and the Honorable C. D. Howe, Minister of Munitions and Supply, honorary member A.S.M.E. The cover bears a portrait drawing of Sir Casimir Gzowski (1813–1898), who was president of The Institute of Canada, 1889–1891.

Among the Local Sections

Value of Research Stressed at War-Production Conference

Hartford Section Joins With Engineering Council to Study Industrial Problems

RESEARCH was seen by Dr. Lawrence W. Bass, director of the New England Industrial Research Foundation, as a means of reviving waning industries, in an address given February 16 at a conference held by the War Production and Engineering Council for Northern Connecticut at the Hotel Bond, Hartford.

Dr. Bass's remarks made at the evening dinner session were particularly appropriate in view of his explanation that during the last 20 years industry in New England has been falling off in volume in comparison with the rest of the nation.

Some years ago the New England Council detected the down-swing in this region's industry, Dr. Bass pointed out, and came to the conclusion that encouragement of research would aid in solving the difficulties caused by this trend.

New Products Committee Established in 1939

The outcome of this decision, according to Dr. Bass, was the establishment by the council in 1939 of a New Products Committee headed by Dr. Karl T. Compton out of which grew the New England Industrial Research Foundation.

Between 300 and 400 persons attended the conference which generally was divided into four parts, the first being the general assembly in the afternoon, followed by three panel sessions, the evening dinner session, and a technical display which ran through both the afternoon and evening.

A. H. d'Arcambal, vice-president, Niles-Bement-Pond Company, West Hartford, was toastmaster at the dinner. Other speakers at the dinner included Dr. C. A. Woodruff, chairman of the area production urgency committee of the War Production Committee, and Governor Raymond E. Baldwin.

Program Designed to Assist Manufacturers

The conference program was designed to assist manufacturers in solving present problems and to present subjects of concern to them during the war period and immediately afterward, and these aims were broadly carried out, especially at the panel sessions.

One of the panel speakers was Leslie M. Bingham, director of development for the Manufacturers Association of Connecticut, who spoke at the panel on Product Development. F. P. Gilligan of Henry Souther Engineering Corporation, Hartford, was chairman of this meeting at which Ernest Thum, editor of *Metal Progress*, and Edward F. Vaill, Jr., of Bakelite Corporation, Hartford, also spoke.

At the panel on Methods Improvement the chairman was A. H. Williams of Haydon Manufacturing Company, Forestville, while the speakers were Captain Robert A. Olson of the Ordnance Department, Springfield Armory, and Herbert F. Goodwin, industrial consultant, Massachusetts Institute of Technology, Cambridge Mass.

The Modern Plant Maintenance panel had as its speakers C. C. Stevens, New Departure, Bristol; S. A. Czarnecki, Hamilton Standard Propellers, East Hartford, and H. R. Benson, Westinghouse Electric & Manufacturing Company, Boston. The chairman was H. W. Benton of Niles-Bement-Pond, West Hartford.

At the general assembly L. C. Smith of Spencer Turbine Co. was chairman with W. F. Costello, chief of the industrial section, Springfield Ordnance District, and Captain D. F. Linsley, chief of the conversion engineering section, Springfield Ordnance District, as the speakers.

Aircraft and Production, Subjects at Baltimore

Alexander Kartreli spoke on the subject of "Interpretation of Flight Test Measurements Pertinent to the High-Speed Problem," at the February 28 meeting of the Baltimore Section. Elementary fundamentals were summarized and certain actual flight-test measurement results were given and analyzed in the light of these fundamentals by Mr. Kartreli.

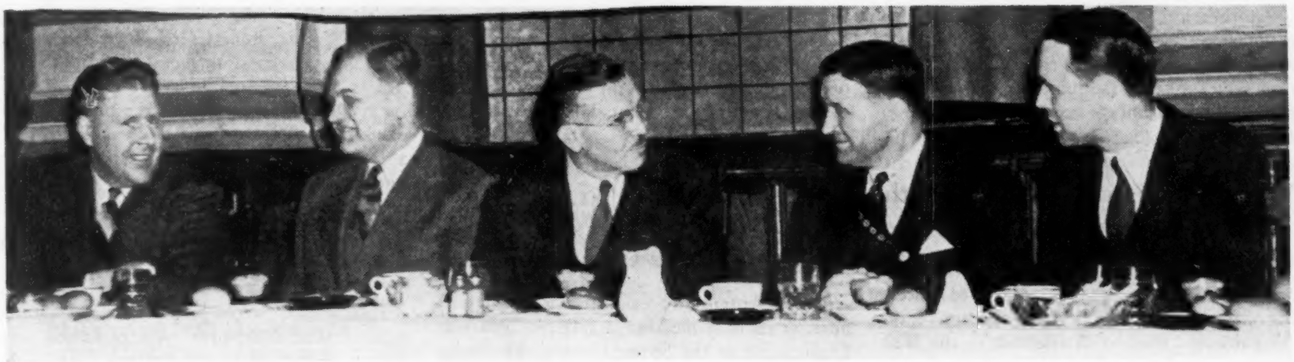
This Section met again on March 27 to hear David W. R. Morgan comment on the "Problems in Manufacturing and Production." Mr. Morgan explained the necessity of conversion of certain classifications of existing personnel into skills most needed, the use of models, and specific job training.

Commander Manning Reviews Ship Program at Boston

At a well-attended meeting of the Boston Section on March 9 Commander George C. Manning, U.S.N. (ret.), reviewed the expansion of shipyards and shipbuilding facilities which has taken place in the United States during the last four years. Mass-production methods have revolutionized the industry, making possible the greatest shipbuilding record in history. The meeting concluded with the showing of a film on modern shipbuilding practice.

Second War Conference Held at Buffalo Section

The Second War Production Conference was held on February 28 at the Hotel Statler, Buffalo, N. Y., by the Engineering Societies of Western New York, at the request of the War Production Board. The guest speaker of the



AT THE SPEAKERS' TABLE, MEETING OF THE BUFFALO SECTION MARCH 21, 1944, HOTEL MARKEEN
(*Left to right:* R. L. Burmester, vice-chairman; Norris C. Barnard, past-chairman; Stanley R. O'Dette, speaker, engineer, Esso Marketers, New York, N. Y.; Carroll A. Ross, chairman; H. P. Fullerton, secretary.)

evening was W. L. Batt, vice-chairman of the War Production Board, Washington, D. C., who spoke on the subject of "Management Looks to 1944." The principal speaker at the afternoon session was Lieut. Col. Bert H. White, Army Air Forces, Matériel Command, Wright Field, who talked on "Increased War Production Through the Technical Advisory Service." Thirteen general topics were covered in separate discussion panels, as follows: "Chemical Industry," "General Foundry Problems," "Maintenance of Electrical Machinery and Equipment," "Civil Engineering in Connection With the War Effort," "Heating, Ventilating, and Air Conditioning Systems and Their Maintenance," "Maintenance and Repair," "Informal Discussion—Safety Consultations," "Welding Problems," "Applied Lighting for War Production," "Industrial-Relations Problems," "Audio and Public Address Work in Industry. Radio Communication and Photoelectric Controls in Power," "Methods—Incentives and Job Evaluation in Industry," and "The Manufacture, Operation, and Inspection of Automotive Vehicles, Aircraft, and Their Component Parts." The toastmaster was E. J. Schwanhausser, vice-president and director, Worthington Pump & Machinery Corporation.

"Turbine Lubrication" and "Maintenance of Lubricating Oil to Give Maximum Oil Life," were topics discussed by Stanley R. O'Dette, engineer, Esso Marketers, New York, N. Y., at the March 21 meeting of the Buffalo Section. Mr. O'Dette approached the subject from a somewhat new point of view. He advocated the use of solvent-extracted paraffin oils which have been subsequently fortified against both corrosion and oxidation and of a nature that would thoroughly wet the surfaces contacted. He also advised the application of proper coatings to the surfaces of the oiling system to protect them from corrosion. Mr. O'Dette is an international authority on lubrication.

Bridgeport to Honor W. R. Webster at Dinner, May 16

At a testimonial dinner to be held on May 16, 1944, at the Algonquin Club, the Bridgeport Section will honor Mr. W. R. Webster upon the occasion of the presentation to him of the A.S.M.E. Fifty-Year Button.

Mr. W. Gilson Carey, Jr., president of the Yale & Towne Manufacturing Co., will be the toastmaster. Officers of The American Society of Mechanical Engineers will attend together with the members of the Bridgeport Section of the A.S.M.E.

Gage-Block Uses Explained at Central Pa. Section

A sound slide-film lecture was given on the theory behind the use of gage blocks by K. P. Brown of the Doall-Pittsburgh Company, at the March 8 meeting of the Central Pennsylvania Section. Mr. Brown explained how gage blocks are made and how gage instruments are used with them. He closed his remarks by emphasizing the importance of close tolerances in war production.

Aircraft Plants and Pressure Cabins, Subjects at Chicago

Members of the Chicago Section met on March 6, to hear J. E. Owens of the Douglas Aircraft Company speak on the subject of "Design and Maintenance Problems of a New Aircraft Assembly Plant." Mr. Owens gave detailed information on the construction of the Douglas-operated Army Air Force aircraft plant, located northwest of Chicago. This is an all-wood plant, because of which special maintenance problems have required solution.

This Section met again on March 15, to hear Dr. John E. Younger describe "Fundamentals of Pressure-Cabin Operation and High-Altitude Flight." Dr. Younger reviewed the early history and discussed in detail the problems and setup at Wright Field in 1935, which led to the first successful pressure-cabin airplane, and which won the Collier Trophy for the United States Army Air Corps in 1938.

Vibration Control Discussed at Joint Cleveland Meeting

Leon Wallerstein spoke on the subject of "Vibration Control" at the March 6 meeting of the Cleveland Section, held jointly with the members of the Machine Design Division of the Cleveland Engineering Society. Mr. Wallerstein gave a brief discourse of his subject, as well as of the mechanical means available to damp vibration in machinery.

R. F. Throne Speaks at Colorado Section

The Colorado Section met on February 23 to hear R. F. Throne speak on the subject of "Relationship of Lake Cooling Surface to Electric Plant Performance." Mr. Throne discussed studies which have been made at the Valmont, Colo., plant of the Public Service Company describing the various conditions affecting lake cooling of condenser water and results of research work carried on at that plant.

This Section met again on March 24 to hear Frank Prouty tell some of his "Experiences on War Construction Work." Mr. Prouty has been engaged in supervising construction on a number of air bases and military depots throughout the West.

Artist-Training Technique Demonstrated at Columbus

Prof. H. L. Sherman, department of fine arts, The Ohio State University, spoke before the Columbus Section on the subject of "How the Artist Sees" on March 2. Professor Sherman discussed and demonstrated a technique he has developed for training people to see things in such a way that they can draw and paint without previous training of the hands. He told the group that if the eyes and mind are trained, the hands will automatically do the right thing. Thirty-five persons were in attendance.

East Tenn. Section Meets With Other Engineers

A joint dinner meeting was held on February 15 by the East Tennessee Section with members of the A.S.C.E., A.I.E.E., and A.C.E., in the Ross Hotel, Chattanooga, Tenn. The principal speaker of the evening was Dr. David Lockmiller, president of the University of Chattanooga, who spoke on "Postwar Educational Problems." Another speaker was Paul C. Spath, who gave a report on two meetings of the Tennessee Association of Professional Engineer Employees recently held in Knoxville. After the talks, the General Electric Company sound movie, "Railroadin'," in technicolor, with locomotives playing the leading roles, was shown.

Another joint meeting of this Section with members of the A.I.E.E. was held on March 1 at which L. W. Morton of the General Electric Company spoke on the subject, "Power Rectifiers." Three members and 72 visitors were in attendance.

W. G. Christy Tells Elizabeth Section How to Save Fuel

William G. Christy, smoke-abatement engineer of Hudson County, N. J., addressed a meeting of the Elizabeth Section on February 16, on the subject, "Fuel—a Bottleneck in the War Effort," which brought home to his audience some of the reasons why a stringency in fuels still prevails. The production and use of coal, oil, and natural gas were reviewed from 1916 to date. His constructive suggestions for eliminating waste and improving operating efficiency of industrial plants were welcomed by the group.

Subject at Erie Section Is "How Coal Burns"

An interesting discourse on "How Coal Burns" was presented by Otto de Lorenzi at the March 14 meeting of the Erie Section. Mr. de Lorenzi spoke of some of the problems involved in and the equipment used for the generation of steam in boilers and showed a two-reel colored motion picture of the actual burning of coal on different-type stokers and the gas flow during the combustion process.

V Belts and Air Conditioning Discussed at Fort Wayne

"What's New on the War" was the topic discussed at the March 8 meeting of the Cleveland Section by J. T. Carroll of the Worthington Pump & Machinery Corporation, Harrison, N. J. Mr. Carroll spoke on the development of V belts for tanks and aircraft, comparing the steel-cable type with the cotton-cord type. He also described developments in air conditioning, using large centrifugal compressors with F-11 as refrigerant. He concluded with the thought that the postwar period offers great promise for the wide application of air conditioning.

"Streamlined Trains" Lecture at Greenville

Prof. R. W. Morton of Knoxville gave an interesting illustrated lecture on "Streamlined Trains" at the March 13 meeting of the Greenville Section. A lengthy question-and-answer period followed Professor Morton's remarks. Prior to the lecture, the Executive Committee appointed Prof. Bernard E. Fernow, of Clemson College, liaison representative of the A.S.M.E. Library Committee.

R. M. Gates Guest of Kansas City Section

R. M. Gates, President of the Society, was the guest of honor at the March 17 meeting of the Kansas City Section. He spoke briefly on several subjects of current interest to A.S.M.E. members. L. L. Jolly of the Doall Company, Pittsburgh, Pa., then spoke on the subject of "Precision Measuring Instruments." Mr. Jolly told of the needs that arose for standards of measurement when the mass-production methods of industry began. His talk was illustrated with slides.

Dinner Meeting to Be Held by Metropolitan Section Junior Group

The Metropolitan Section Junior Group will hear, at its May meeting, a talk on "Postwar Engineering in the Soviet Union," by Simon Breines, prominent New York architect of the firm of Pomerance & Breines. Mr. Breines is a graduate architect and a member of the American Institute of Architects. His first connection with the Soviet Union began in 1932 when he was awarded the prize in an international competition in architectural design for the Palace of Soviets. The speaker is expected to

SIMON BREINES

describe some of his personal experiences which involved unusual architectural and engineering requirements encountered by the Russians and will discuss the conditions and circumstances for postwar engineering in Russia. The meeting will be held at Child's Restaurant, 109 West 42nd Street, New York, N. Y., on May 23. Dinner will be served at 6:30 p.m. (about $1 a person) and the business meeting will start around 7:30 p.m. Members and guests unable to attend the dinner are invited to the evening meeting.

Armin Elmendorf Discusses Wood Products at Milwaukee

New techniques in the application of wood, plywoods, and wood products in engineering were revealed by Armin Elmendorf at the Milwaukee Section meeting held on March 8. Mr. Elmendorf, who was formerly of the Forest Products Laboratory, University of Wisconsin, told of the various processes for making pressboard, celotex, and other newer plastic-bonded building boards, and exhibited samples of veneers and plywoods in various shapes, as well as various fibers and materials used in processing. Slides illustrated his talk.

Magnesium Production and Use Described at Providence

On March 7 the Providence Section heard James B. Reid of the Dow Chemical Company speak on the subject, "The Working of Magnesium." Mr. Reid described the methods of producing magnesium metal and the various alloys of magnesium and gave practical hints on handling magnesium in the production of sand castings, permanent mold castings, pressure die castings, deep drawing, press forgings, and the like.

Joint Dinner Meeting Held at Rochester Section

Instructions in the proper use and care of measurement equipment were presented, in a manner entertaining and simple enough to be of interest to both novice and experienced alike, by Maurice A. Singer, at the joint dinner meeting of the Rochester Section and the Rochester Engineering Society, held at the Sagamore Hotel, Rochester, N. Y., on March 16. A laboratory demonstration followed the formal talk and movies.

Virgil M. Palmer Dies, First Chairman of Rochester Section

Virgil M. Palmer, member of the Rochester Section, died on February 16. A native of Windsor Locks, Conn., Mr. Palmer was graduated from the Massachusetts Institute of Technology in 1903. He became affiliated with the Pope Manufacturing Company, Hartford, Conn., and successively held key positions with the Smith Auto Company, Topeka, Kan., the Selden Motor Company, Wilkes-Barre, Pa., and the U. S. Motor Company, New York, N. Y., before joining the Eastman Kodak Company, Rochester, N. Y. Mr. Palmer was one of the organizers and also first chairman of the Rochester Section of the A.S.M.E., which was formed in 1919. He was president of the Rochester Engineering Society, 1930–1931, having served as vice-president the previous year. He had served on numerous committees of this Society during the 30 years of his membership and was the author of many papers and articles on industrial engineering and management. In addition, Mr. Palmer was a member of the Society of Industrial Engineers, the American Management Association, the Rochester Torch Club, Genesee Falls Lodge F.&A.M., Rochester Consistory of the Scottish Rite and Damascus Temple of the Shrine. He also had served as president of the National Council of State Boards of Engineering Examiners and was a former national director and president of the Society of Industrial Engineers.

R. M. Gates Outlines Postwar Training Program at St. Louis

Co-operation between industry and the engineering profession to help solve such postwar problems as aiding soldiers and discharged war workers to re-enter civilian occupations, and applying modern science to raise living standards and secure freedom from want, was advocated by Robert M. Gates of New York City, President of the Society, at a dinner in his honor on March 13 by the St. Louis Section.

Mr. Gates stated that military training is giving thousands of young soldiers and sailors sufficient engineering experience to convince them that engineering as a profession offers them a worth-while future. He added that in-

dustry, schools, and engineering societies should draw up an educational program to satisfy these men when they return, in order that they may contribute as much in the postwar era as they did toward winning the war.

Future for Coast Steel Plants Discussed at San Francisco

Explaining that miracles were not to be expected but that adequate steel-manufacturing capacity would be available and the demand for steel high, G. L. von Planck and Dr. John E. Dorn on March 23 spoke to an enthusiastic group of the San Francisco Section on the subject of "The Future of Metals on the Pacific Coast." Mr. von Planck covered the subject related to ferrous metals, while Dr. Dorn touched on the use of light alloy manufacture.

This Section met again on March 6, to hear Dr. John E. Younger give a talk on "Aircraft Structures, Past, Present, and Future." He reviewed the development of airplane structures from the earliest planes to the present time and predicted the future trend of developments in airplane structures.

Alf Hansen spoke on the subject of "Turbosuperchargers" at the March 16 meeting of this Section, leading an exceptionally interesting discussion on the turbosuperchargers.

South Texas Section Enjoys Comments of David Morgan

The South Texas Section met on February 3 to hear David W. R. Morgan give an excellent talk on "Condensers and Pumps." Mr. Morgan, who is a vice-president of the Society and works manager of the Steam Division, Westinghouse Electric & Manufacturing Company, Philadelphia, Pa., spent about equal time discussing gas turbines, condensers, and pumps. He used a number of lantern slides to illustrate his remarks. Nearly 100 members and guests were in attendance.

Heat Control in Manufacture of Brass Heard at Waterbury

Automatic control of heat in the manufacture of brass, including historical data and development of various types of equipment, was reviewed by H. R. Bristol, before members of the Waterbury Section at a meeting on March 23.

Col. J. C. Damon Reviews Power-Supply Problems at Meeting of Western Massachusetts

In his speech before the members of the Western Massachusetts Section on March 1, Col. John C. Damon, assistant to the president, Hartford Electric Light Company, referred to the condition of the power industry in the United States in 1914, when it was completely unprepared for war, and just before the present conflict, when the situation was well under control. In 1914, he stated, there was about one fifth of the power available, compared with 1939. Many power companies made no attempt to co-operate with others in seeking solutions for their problems, and practically no interconnections between systems existed. In the present war, he continued, with the experience previously gained, the power companies have been in a better position to take care of the tremendously expanded power requirements. Much data had been assembled by the utilities and by the Federal Government so that the problems which did arise could be taken care of advantageously with a minimum of lost time. The only serious power shortage, he added, in this war, occurred in the Southeast in 1941. However, this was not the result of poor planning but was caused by a serious drought in that area.

West Virginia Section Hears Herron on "Engineering"

Speaking before a joint meeting of the West Virginia Section and the Charleston Junior Engineers Association on February 22, James H. Herron, past-president of the Society, declared that engineering as a profession is not known, as it should be, to the general public. This condition can be corrected if the engineer will take an active interest, not only in his professional society and the furthering of its welfare, but also in related fields. Among the most important of his interests should be civic and community activities to which he can contribute both as a citizen and as an engineer. Following Mr. Herron's discussion, a moving picture entitled, "Power by Octane," was shown.

Dr. Younger at Western Washington Meeting

Members of Western Washington Section held a meeting on March 9, at Spokane, to hear Dr. J. E. Younger speak on the subject of "Airplane Structures, Past, Present, and Future." Ninety members and guests were in attendance.

With the Student Branches

Film "Fortress in the Sky" Shown at California Tech

An interesting motion picture, "Fortress in the Sky" was viewed by members of CALIFORNIA TECH BRANCH on February 8, after which the members listened to a talk on "100 Octane Gasoline—the TCC Process," by James Tuedio, one of the chapter members. Plans for the coming year were also discussed at this meeting.

The importance of building up the A.S.M.E. membership and results of the campaign being conducted were discussed at the March 16 meeting of the UNIVERSITY OF CALIFORNIA BRANCH. Those present were asked to make every endeavor to recruit two new members each, for which purpose membership applications were distributed. It was also decided to hold future meetings in the afternoon instead of evenings as heretofore.

Prof. Roscoe W. Morton, head of the mechanical-engineering department, University of Tennessee, spoke on the subject of streamlined trains to the engineering students at CLEMSON A.&M. COLLEGE BRANCH on March 14. Professor Morton is district counselor of the A.I.M.E. Interesting slides were shown during his lecture.

The Clemson Junior Branch met at Clemson College on the morning of March 14 to hear Professor Morton lecture on "The History of Pumping Machines." A total of 80 were in attendance.

A decision to hold joint meetings of the A.I.E.E. and A.S.M.E. was reached at the January 10 meeting of the COLORADO STATE COLLEGE BRANCH. At the same meeting an invitation was extended to this Branch to attend the annual meeting of the Colorado Section of the A.S.M.E., which was accepted.

COLORADO UNIVERSITY BRANCH met on March 22, for the purpose of electing new officers, enlisting new members, and starting a general drive to increase active interest in the organization. Those elected include: Thomas E. Taylor, student chairman; Donald R. Belknap, student vice-chairman; John J. Stark, secretary; and Willard E. Bain, treasurer.

Election of officers was held at the first meeting of the new semester of the CONNECTICUT BRANCH, February 16, as follows: George B. Towle, chairman; Gregory Battick, vice-chairman; Mario J. Marinaccio, secretary; and Ray Sweet, treasurer. After the election of officers, Mr. Butler told the members how the military authorities felt about the Army Specialized Training Students joining the Student Branch of A.S.M.E.

Official notice was given to members at a meeting on February 23 of COOPER UNION BRANCH that the Branch would act as host at the student conference scheduled for the latter part of April. The meeting was then turned over to Frank L. Koniges, a student member of the chapter, who delivered a paper on "Gas Turbines." This Branch met again on March 3 to see the interesting technicolor movie, "Making the Big Inch." Thirty members were in attendance.

In an address on February 8 at the first meeting of the newly reorganized CORNELL BRANCH, Mr. Harding of the Rochester Gas & Electric Company spoke on the subject of "Not in the Textbook." Following his talk the motion picture "Cannon With Wings," was shown. The picture showed many interesting details of the manufacture of the Bell Airacobra, with particular emphasis on the methods of simplifying production.

DREXEL BRANCH has initiated a chapter Bulletin, *The Exhaust*. *The Exhaust* was published for the first time on October 15, 1943, in an attempt to give members full information about the Branch, school affairs, and other engineering information which the members might otherwise never hear about. It is published twice a term by its members. In addition to the chapter bulletin, this Branch also issues questionnaires from time to time, asking aid in selecting subject matter, type of meetings preferred, and the like.

This Branch held a combined meeting with the Drexel A.I.Ch.E. chapter on February 2 at

which the main speaker of the evening was Robert Riddle, personnel director of the Kellet Aircraft Corporation, Philadelphia, Pa. Mr. Riddle discussed the topic "What Industry Requires of You," after which the General Motors sound movies, "Modes and Motors" and "Frontiers of the Future," were shown.

H. S. Evans was elected president at the January 11 meeting of DUKE BRANCH. Other officers elected include: Bill Dackis, vice-president; Gil Brandon, secretary; and Claude Williams, treasurer. At the March 7 meeting of this Branch, committees were selected as follows: Program Committee—Bill Dackis, chairman, Paul Long, and J. Lodor; Publicity Committee—Gil Brandon, chairman, and Neal McGuire. Plans for attending the Annual Student Conference at Baltimore the latter part of April, and papers to be presented, were then discussed. This Branch met again on March 22 to prepare plans for a social as well as a picnic. Final plans also were made for attending the Baltimore meeting.

Banquet Held in Honor of Col. James L. Walsh

A banquet was held in honor of Col. James L. Walsh, chairman of the War Production Committee of the A.S.M.E., and guest speaker at the March 13 meeting of the FLORIDA BRANCH. Colonel Walsh spoke on the subject of "Logistics" or the science of supply which he said offers a direct challenge to every one on the home front. He pointed out the particular phase of the work which the engineer should perform, emphasizing the fact that no group or particular science had a monopoly on this study.

The IDAHO BRANCH met on February 22, to elect Bob LaRue chairman, to succeed Bob Pointer, who graduated at mid-semester. "Doc" Watson was unanimously elected vice-chairman to replace Bob LaRue. Plans for a dinner-dance were then discussed.

After viewing a movie, "Heat and Its Control," by Johns-Manville, members of the IOWA STATE BRANCH on March 1 elected new officers as follows: Sol Bucksbaum, president; Nick Pergakis, vice-president; Frank Hunter, secretary; Eloise Heckert, treasurer; and Harry Bahr, junior representative. This Branch met again on March 29 to hold a short business session at which President Bucksbaum appointed Frank Hunter to head a committee which would select a representative to attend the forthcoming Midwest Student Branch Conference.

Louisiana Branch Reports on Four Meetings

On November 10 the LOUISIANA BRANCH met to hear Tom Evans of Curtiss Wright give a talk on "External Loading Conditions in Aircraft." At the November 22 meeting W. Heimendinger and F. Reaves presented papers on "Measurements With Light Rays," and "Torpedoes," respectively. The Branch met on December 1 to make plans for a lounge room for use of members, and to discuss the possibility of holding a "Father and Son Banquet." After the meeting a motion picture, "The Navy and Its Ships," was shown. At the fourth meeting, December 15, members heard Z. Zabban speak on "The Opportunities for Engineers in Brazil."

At the regular meeting of the MICHIGAN MINING AND TECH BRANCH on February 22, the chairman announced the appointment of the following officers: B. J. Ellerthorpe, chairman; Charles Larson, vice-chairman; Delevan P. Young, secretary; and George Siekpinen, treasurer. Members of the technical societies of A.I.E.E., A.I.Ch.E., A.I.M.E., A.S.C.E., and A.S.M.E. met at this Branch on March 7, and enjoyed the film, "Target for Tonight." After the film was shown, a short business meeting was held at which a special committee was selected to work out a program for the next joint meeting to be held sometime in April.

Sam Hardy of the F.B.I. Speaks on Sabotage Problems

Sam Hardy of the Federal Bureau of Investigation spoke on the problems of the F.B.I. combating sabotage in wartime at the February 1 meeting of the MINNESOTA BRANCH. Mr. Hardy also answered many questions asked by the members regarding the work of the F.B.I.

Student members of the MISSOURI BRANCH presented short technical papers on February 23. Pfc. J. H. Peebles discussed the advantages and disadvantages of radial and in-line aircraft engines; Pfc. R. L. Graham explained the Graham variable-speed drive used in the very successful new aircraft tracker; while research on a problem presented by an aircraft plant was the topic of Pfc. F. Lebensart. At the March 8 meeting of this Branch a moving picture, "Sinews of Steel," was presented by the Bethlehem Steel Company which gave detailed information of the fabrication of wire rope.

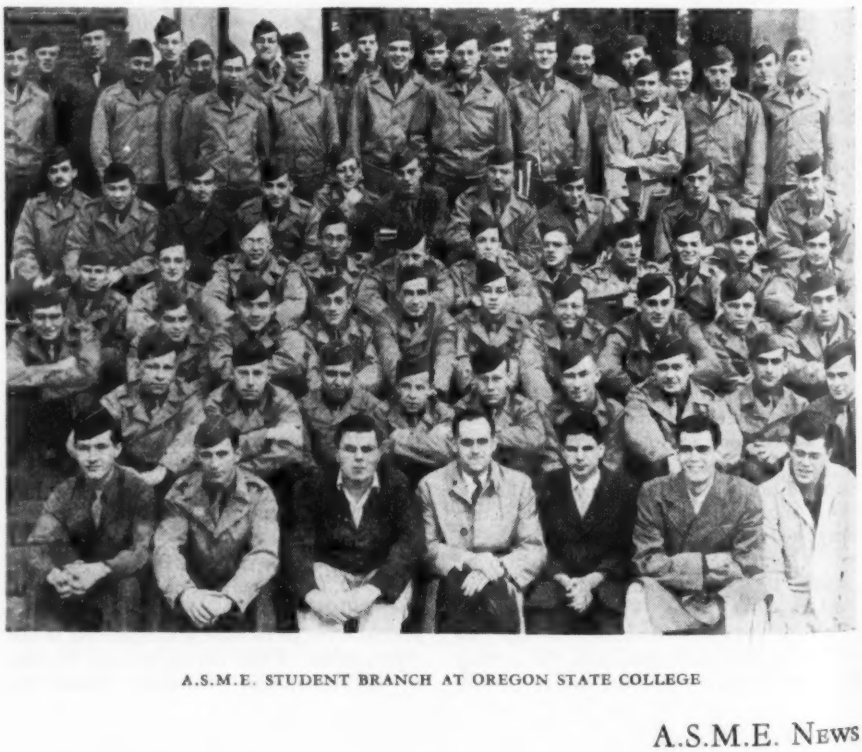
Prof. Arthur C. Coonradt, chairman of the department of mechanical engineering, told members of the NEW YORK UNIVERSITY (Day) BRANCH on February 10 how to build engines under the subject, "Engineering Can Be Fun." Professor Coonradt told of some of his college and engineering experiences and gave the members excellent advice for success in engineering. The subject of "Helicopters" was well exhausted at a joint meeting of this Branch and the members of the I.A.S., on March 9, when W. Ayres, assistant chief engineer of the Sperry Gyroscope Company, New York, presented a two and one-half hour lecture with slides on the helicopter. This Branch sponsored a novel informal dance for the College of Engineering on March 11 in the mechanical-engineering laboratory. At the March 23 meeting of this Branch, held in conjunction with the A.S.C.E., Dr. Ole Singstad, the noted tunnel authority was the principal speaker. Dr. Singstad has been connected, either as chief engineer or in an advisory capacity, with practically every major tunnel project in the country. His talk was supplemented with slides.

Professor Walters of the mechanical-engineering department, spoke at the NEWARK COLLEGE OF ENGINEERING BRANCH on March 17. The meeting was sponsored by the mechanical-engineering students, and members of the Civil, Electrical, and Chemical Engineering Society branches participated. After a brief address on the benefits derived from joining a professional society, a film, "Target Germany" was shown.

Dance and Entertainment Enjoyed by Northeastern Branch

The annual A.S.M.E. dance was held on February 12 by the NORTHEASTERN BRANCH, following the Northeastern University-Rhode Island State basket-ball game. Other attractions of the evening included a Russian ballet by Adolph Katz, piano selections by Norm Sessler, a humorous skit by Adolph Katz and James Russo, as well as music by "Spike Jones," a six-man band. This Branch met again on February 23 for the purpose of viewing the technicolor sound film "Cannon on Wings," obtained through the Bell Aircraft Corporation, which showed the construction of the P-39 by modern mass-production methods. On March 16, this Branch met to enjoy a colored film "Flying Forts," which showed the development and production of the B-17 bomber, and the movie "Cyclone Combustion," lent by Wright Aeronautical Corporation.

Prof. P. W. Ott of the mechanics department,



A.S.M.E. STUDENT BRANCH AT OREGON STATE COLLEGE

Ohio State Branch, on February 11 gave an illustrated talk concerning the uses of scale models in the engineering field. The regular meeting of this Branch was held on February 25. After a short business session, a film in technicolor of the B-17 Flying Fortress was shown. The chairman then called for an election of officers and the following men were selected: Preston R. Crabill, chairman; Norman W. Hopwood, vice-chairman; Jim Scott, secretary; and John H. Stand, treasurer.

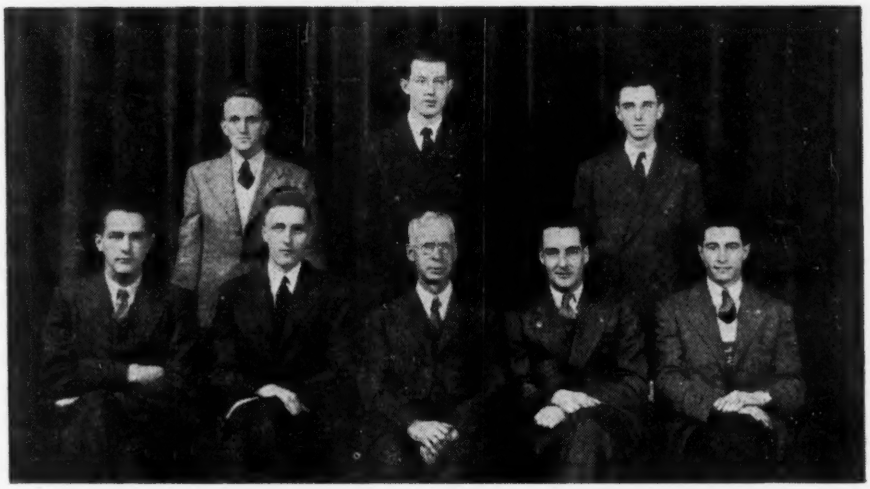
Officers were elected at the February 11 meeting of the Oklahoma Branch, as follows: Pfc. C. Axelrod, chairman; Sgt. T. Coryat, vice-chairman, and Pfc. Bill Houle, secretary and treasurer. After the election, plans were made to hold a smoker on February 17, with Ed Levy in charge.

Shipyard and Plant Tours Feature Oregon State Sessions

Sixty-two student members and two faculty members attended the December 10 meeting of the Oregon State Branch, at which Professor Hughes explained how "graduating" A.S.T. students could apply for junior membership in the Society. A motion picture, "Sinews of Steel," was then presented by the Bethlehem Steel Company, after which officers for the next term were elected, as follows: John Boehm, chairman; George Keane, vice-chairman; Richard Myers, secretary; Gerald McNally, treasurer; and Vincent Brooks, publicity chairman. This Branch, on December 12, went on an inspection tour of the Iron Fireman Manufacturing Company's steam-engine plant, after which the group visited the Oregon Shipbuilding Corporation's yard, to witness the launching of a Liberty ship. An inspection trip through the shipyard, as well as a visit aboard the Diesel dredge *Clackamas*, owned and operated by the Port of Portland, completed the engineering phase of the trip. A joint meeting of the Branch was held on January 14, with the A.I.E.E. student branch, at which Prof. A. L. Albert, head of the electrical-engineering department of Oregon State College, spoke on "Industrial Electronics." A Westinghouse film, "Electronics at Work" was a feature of the meeting.

New Officers Elected at Purdue

The Purdue Branch held its last regular meeting of the first semester on February 17 at which a new group of officers was elected. They are: J. J. Schocken, chairman; H. N. Davidon, H. W. Grube, R. C. Hupp, D. R. Pliske, vice-chairmen; W. K. Price, secretary and treasurer; and Prof. R. W. Leutwiler, honorary chairman. Following the election Dr. R. B. Withrow of the physics department gave an illustrated lecture on the "Construction and Operating Principles of the Cyclotron." This Branch met again on March 15 to hear J. A. Hardy of the mechanical-engineering staff give a talk on "Electronic Pressure-Measuring Devices." Mr. Hardy demonstrated the device with a standard CFR engine. The annual speech contest of the Branch was held on March 22. John H. Colby (M.E.3), marine trainee, won first honors in the contest. He gave an interesting talk on "Rocket Projectiles," in which he presented a brief history of the development of the rocket projectile and then discussed the rocket projectile in modern warfare. Second honors went to John E. Loufek (M.E.7), who gave a good talk and demonstration of "Wing Flutter," while third prize was won by M. J. Schocken (M.E. 8), who spoke on "Human Machines." The prizes were $15 in cash, a "Marks' Mechanical Engineers Handbook," and a copy of "Machinery's Handbook," respectively. Judges were Professors Bruhn, Geiger, Leutwiler, and Spalding of the School of Mechanical and Aeronautical Engineering, and Professor Horn of the Speech Department.



A.S.M.E. EXECUTIVES 1943-1944 UNIVERSITY OF TORONTO STUDENT BRANCH

(*Top row, left to right:* R. E. Penfold, IV year representative; D. C. Elves, II year representative; E. M. Peacock, III year representative. *Front row, left to right:* R. T. Mansell, secretary-treasurer; J. D. Abell, chairman; Prof. R. W. Angus, honorary chairman; A. R. Hamilton, vice-chairman; G. A. Lorimer, papers and meetings member.)

Rensselaer Branch Learns of Future Gas-Turbine Applications

J. Kenneth Salisbury of the turbine engineering division, General Electric Company, Schenectady, N. Y., was guest speaker at a joint meeting held March 6 by the Rensselaer Branch with the A.I.E.E. and A.I.A.S. Mr. Salisbury, who spoke on the subject of "Gas Turbines" traced the history of the internal-combustion engine and the gas turbine from 1680 and predicted a still greater future for gas turbines, with applications possible in the aircraft, marine, control station, and land transportation fields.

It was decided at the March 2 meeting of the Rutgers Branch that Professor George of the history and political science department be asked to speak at the next meeting of the Branch. After the business session Sam Goldfarb gave a talk on "The Engineer's Job in the Shipyard" which was enthusiastically received by the 15 members present.

The first meeting of the Spring term of Syracuse Branch was held on February 22. Prof. John King, honorary chairman and head of the mechanical-engineering department, addressed the group, giving a brief history of the student branch and advising the new members of the advantages to be gained through this organization. At the close of the meeting a film, "East of Bombay," was shown through the courtesy of the Chrysler Corporation.

Feature of the February 24 meeting of the Tennessee Branch was a talk by D. F. Wolfe of the Fulton Sylphon Company. Mr. Wolfe gave a brief review of the history of the Fulton bellows pointing out the growing uses of the bellows. A short discussion of a skit to be presented at the Engineer's Banquet followed Mr. Wolfe's address.

Distribution of Technical Literature Features Toronto Activities

Technical literature, obtained by the Toronto Branch and distributed among its student members during the course of the year, included 100 copies per month of special inserts appearing in *Product Engineering* magazine, entitled "Steel Castings," "Plastics," "Electronics," "Finishes," and "Hydraulic Controls." Another article entitled "The Technical Editor Speaks," was obtained from the International Nickel Company. This Branch is now awaiting a further supply of booklets entitled, "Quality Control," from the Doall Gage Company.

Many Papers Presented at West Virginia Branch

During the months of February and March the West Virginia Branch held six meetings. At the February 14 meeting the combined group of members of the A.S.M.E. and the Mechanical Engineering Society, elected officers as follows: B. Judy, president; R. E. Jenkins, vice-president; R. Hewitt, secretary; R. Fisher, treasurer, and W. McCoy, sergeant at arms. The date, topic, and the names of the persons presenting papers, at the other five meetings are: February 21, "Wartime Shipbuilding Program," by R. Fisher; "Glued Laminated Lumber Construction," by R. E. Jenkins; and "The 2500-Psi Twin Branch Plant Operating History," by B. Judy. February 28, "Inflatable Life Rafts," by H. Combs; "Increasing Tool Life by Better Tool-Finishing," by W. McCoy; and "Stress and Strain Analysis by Brittle Lacquer," by T. Pritchard. March 13, "Quality Control in the Manufacturing of Small-Arms Ammunition," by George S. Chadwick; "Railroad Equipment in Wartime," by D. Clark; and "Powder Metallurgy," by D. Triont. March 20, "Heat-Treating Machine Gun Links," by R. Fisher; "Chip-Disposal Methods," by M. Hoover; and "Boiler for 2500-Psi Plant," by B. Judy. March 27, "Wartime Designs," by R. E. Jenkins; "The New Jet Plane," by W. Combs; and "The Problem of Selecting Materials for Bearings," by T. Pritchard.

Papers presented at the March 14 meeting by

student members of the YALE BRANCH included, "Who Was Alan Pinkerton?" by B. C. Bellows; "You May Write as You Please," by A. H. Swett; "Poils," by B. M. Thompson, and "Plastics and Their Uses," by P. B. Danly. At the March 21 meeting of this Branch, it was decided to participate in a joint meeting and forum of the several student engineering societies. Student members then presented papers as follows: "I Want to Be a Deep Sea Diver," by R. C. Olson; "Television," by R. A. Gertz; "There's Something About a River," by J. A. Thomas. This Branch met again on March 28 to hear the following speakers: W. O. Blattner, who spoke on "Utilization of Human Resources; D. Nardelli, on "About New York;" V. Levi D'Ancona, on "Railways in Italy;" and M. Wander on "Jet Propulsion System." Speakers heard at the April 4 meeting include: J. H. Andrews, on "Rocket Grenade Lance M1;" B. F. Olson, on "Our Maritime Renaissance;" J. deC. Frederick, on "Elusine Island," and A. Sherman, on "Now What about Jacko."

Postwar Planning Outlined at Hawaii

HAVING given great deal of study to postwar planning, Dr. R. C. Hoeber, associate professor of economics and business, University of Hawaii, capably spoke on that particular subject to members of the Engineering Association of Hawaii at a luncheon meeting on March 17. Dr. Hoeber handled the problem with unusual analytical ability. After his speech, members viewed two sound movies entitled, "The Marines Have Landed," and "Marines Capture Tarawa."

To Advise Railroad Industry on Research

FOR the purpose of advising the railroad industry on research matters, Clyde Williams, director of the Battelle Memorial Institute of Columbus, Ohio, has been engaged by the Association of American Railroads as technical consultant.

Mr. Williams will make a study of the railroads' technical problems with a view to coordinating and organizing research relating to technological methods and processes. His office will be located at 59 East Van Buren St., Chicago, Ill.

Summer Management Course at Iowa

THE College of Engineering of the State University of Iowa, Iowa City, Iowa, announces that it is again offering a three-week summer course in management, designed primarily for persons in industry "who want comprehensive training in production planning, plant layout, motion and time study, wage incentives, and related subjects." The course, combining fundamental training with practical applications, will run from June 12 to June 30 with well-known managers and industrial engineers conducting lectures.

For complete information, tuition, fees, and living expenses, communications should be addressed to Prof. Ralph M. Barnes, Industrial Engineering Department, College of Engineering, University of Iowa, Iowa City, Iowa.

Information Wanted on Buttress Screw Thread

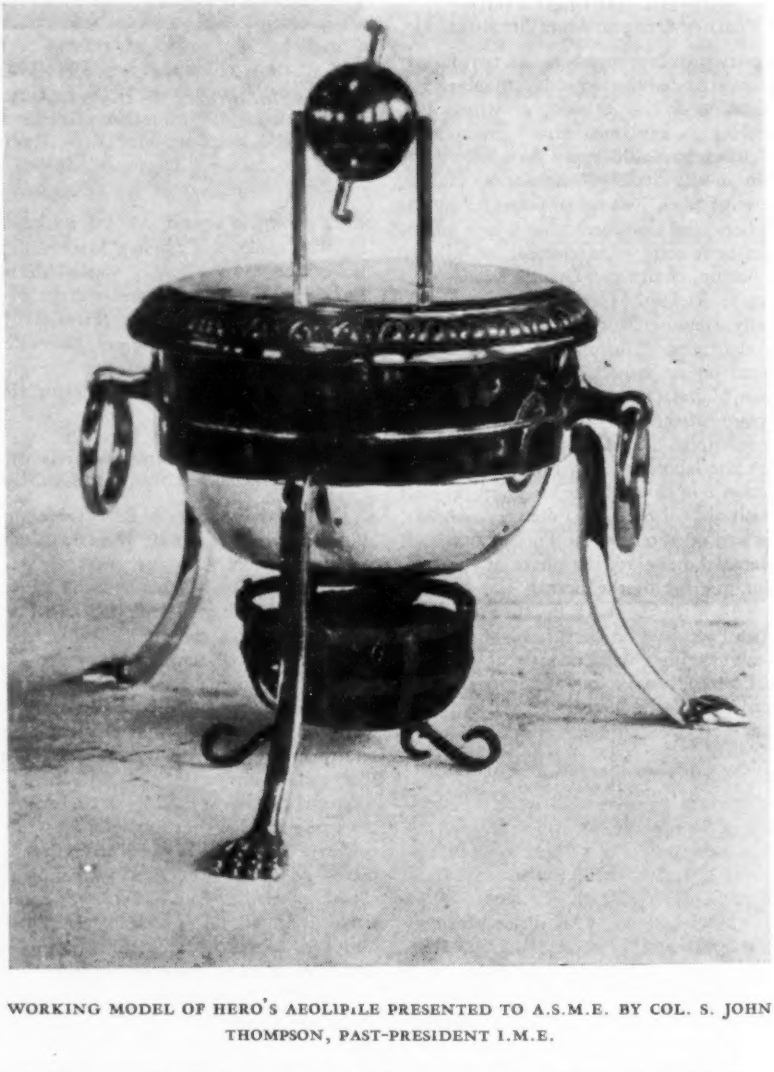
THE war effort has developed a need for the standardization of buttress screw threads. The Sectional Committee on Standardization and Unification of Screw Threads, B1, Interdepartmental Screw Thread Committee, and General A.S.A. War Committee are all interested in helping to bring about the setting up of such a standard at the earliest possible moment. F. E. Richardson has been asked to gather all available data on the design, production, and commercial application of this type of screw thread in industry.

Those who have information of this kind will help our national war effort by sending it in duplicate, if possible, to Mr. Richardson, care of The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

S.E.S.A. to Meet in Boston May 18–20

THE spring meeting of the Society for Experimental Stress Analysis, including a symposium on residual stresses, their measurements and effects, will be held at the Hotel Statler, Boston 17, Mass., May 18 through 20, 1944.

Inquiries should be addressed to the S.E.S.A., P. O. Box 168, Cambridge 39, Mass.



WORKING MODEL OF HERO'S AEOLIPILE PRESENTED TO A.S.M.E. BY COL. S. JOHN THOMPSON, PAST-PRESIDENT I.M.E.

Model of Hero's Aeolipile presented to A.S.M.E.

COL. S. JOHN THOMPSON, immediate past-president of The Institution of Mechanical Engineers, has presented to The American Society of Mechanical Engineers a model of Hero's Aeolipile, prototype of the steam turbine. He says in his presidential address of October, 1942: "About 150 B.C. Hero of Alexandria constructed an engine and boiler combined which is considered to be the first workable design of steam turbine." Thus some twenty centuries ago was the idea of the steam turbine, and of the reaction water turbine also, born. The model may be seen at the headquarters of the Society.

The model is a beautiful piece of workmanship and includes the copper bowl to which a brass lid was braised. Underneath the bowl is a charcoal brazier. Water is placed in the bowl through a threaded hole which is plugged. When the water is converted into steam it rises through the two vertical members and enters the ball which is free to move on its horizontal axis. Steam discharged through the two tubes gives motion to the ball.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Boston, Mass.	Chicago	Detroit	San Francisco
8 West 40th St.	4 Park St.	211 West Wacker Drive	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

ENGINEER-EXECUTIVE with broad, successful experience as general manager, superintendent, chief engineer. Intimate knowledge of mass-production methods, equipment, tooling, incentives, systems, precision quality, standardization, design, development, invention. Desires connection having postwar possibilities. Me-840.

ASSISTANT TO PRESIDENT or executive position desired utilizing 20 years' experience in all phases of manufacturing, including systems, production, arrangement, design, engineering, sales, advertising, marketing, cost accounting, and departmental co-ordination. Me-841.

[1] All men listed hold some form of A.S.M.E. membership.

POSITIONS AVAILABLE

MACHINE-TOOL SALES ENGINEER, 30–45, familiar with turning tools. Man should have some machine-tool selling experience. Salary and commission about $5000–$8000 year. Office location, Newark; territory, Middle West. W-3514.

ENGINEER to head production-engineering department. Should have well-grounded knowledge of tool design, tool-room practice, machine methods, and drafting. Department is responsible for design and selection of tools and equipment required to make products. Department also responsible for developing technical changes in process of manufacture to reduce costs and analyze difficulties. $4884–$7440 year. Pennsylvania. W-3520.

DEVELOPMENT ENGINEER, either graduate mechanical or aeronautical, to design aeronautical controllable-pitch propellers. Must be engineer who through experience would be capable of accepting full responsibility for project. Salary open. Middle West. W-3527-C.

ENGINEERS. (*a*) Plant engineer, 35–50, preferably mechanical with knowledge of electrical engineering, with previous experience preferably in plant employing not over 1500 men. Must be extremely cost-minded and able to accomplish results with not too large a department. Duties include installation, maintenance, repairs, inventory and service data, safety devices, power, lighting, heating, cooling, water supply, sewage disposal, and handling of raw materials to stores. $5500 a year. (*b*) Junior engineers or draftsmen. Salaries, $2600–$3380 a year base rate, plus overtime for 52-hour week. (*c*) Tool-and-die engineer familiar with sheet-metal products, steel stampings, aluminum stampings, brake work, etc., jigs and fixtures for welded assemblies. $4680 year for 52-hour week. (*d*) Junior engineers, estimators, or time-study and job-analysis men with at least high-school, preferably engineering or shop, background. Virginia. W-3531.

PRODUCTION EXECUTIVE, 38–45 top, to be assistant to present production supervisor of large pharmaceutical manufacturer. Should have either mechanical or chemical degree and must have some experience in production of packaging goods. Prefer southerner or man who has lived many years in South. $6000–$8000 year. North Carolina. W-3533.

GRADUATE MECHANICAL ENGINEER. Prefer man who has worked up through shop to assist development engineer in development of new mechanical device. Work will involve bench-work. Later to instruct new men on problems of assembly and generally assist development engineer in manufacture. Splendid postwar opportunity. Salary open. New York, N. Y. W-3537.

ASSISTANT TO DIVISION ENGINEER, not over 45. Must have successful executive experience in management rather than staff work. Must have extensive background in machine-shop program. $10,000 year. Florida. W-3539.

FACTORY MANAGER, 35–45. Should have at least 7 years' manufacturing operations with at least 3 years in responsible position in charge of factory or department where he actually exercised management functions. Company manufactures metal and paper containers and has about 300 to 500 employees. $6000–$8400 year. New York, N. Y. W-3540.

MANAGEMENT ENGINEER to survey and revise a going manufacturing plant with respect to changes in methods, plant layout, personnel, etc. Also to co-ordinate postwar plans regarding manufacturing possibilities, legal requirements, personnel, etc. $6000–$7000 year plus 15 per cent bonus. New York metropolitan area. W-3547.

GRADUATE MECHANICAL ENGINEER, 45 top, for steam power-plant work. Will be required to make study of existing plants and determine extent of placement necessary to put apparatus in good working condition. While emphasis is placed on steam end of this work, applicant should have knowledge of electrical generation as well. Salary open. Permanent. New Jersey. W-3558.

CHIEF ENGINEER experienced in small castings and machining field on steel, bronze, and brass. Permanent. $7500 year. Eastern Pennsylvania. W-3569.

MECHANICAL ENGINEER experienced in layout and design for materials-handling equipment. Excellent opportunity in company specialized in design and construction of storage and handling facilities for all granular materials. Must have good working knowledge of all kinds of conveyers, elevators, hoists, trolley buckets, etc. Permanent. $4000–$4500 year. New York, N. Y. W-3576.

PRODUCTION ENGINEER. Must have experience in production and manufacturing of sheet metal, i.e., heat-treating, pressing, and drying sheet metal and steel tubing. Some experience with furnaces and presses and strength and structure of materials. $6000 year. Connecticut. W-3588.

MECHANICAL ENGINEER to co-ordinate engineering with machine shop. Must have good shop background. $7500–$8000 year. northern New Jersey. W-3635.

GRADUATE MECHANICAL ENGINEER with experience in job evaluation with management consulting firm. Should have good knowledge of shop practice. Must be mature enough to be left on his own. $4200-$5000

A. S. M. E. Calendar

of Coming Meetings

May 8–10, 1944
A.S.M.E. Oil and Gas Power Division Meeting
Tulsa, Okla.

June 5–9, 1944
A.S.M.E. Aviation Division Meeting
University of California
Los Angeles Campus
Los Angeles, Calif.

June 16–17, 1944
A.S.M.E. Applied Mechanics Division Meeting
Chicago, Ill.

June 19–22, 1944
A.S.M.E. Semi-Annual Meeting
Pittsburgh, Pa.

October 2–5, 1944
A.S.M.E. Fall Meeting
Cincinnati, Ohio

October 23–24, 1944
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions, Charleston, West Va.

November 27–December 1, 1944
A.S.M.E. Annual Meeting
New York, N. Y.

(*For coming meetings of other organizations see page 48 of the advertising section of this issue*)

year. Some traveling. Headquarters, New York, N. Y. W-3647.

DEVELOPMENT ENGINEER. Must be graduate electrical engineer with good mechanical background. Must have good insight into economic design as peacetime product is sold in highly competitive market. Prefer man whose experience has been in small fractional-hp motors, switches, circuit breakers, electric fans, ventilators, or other electric-mechanical devices. Postwar opportunity. Salary open. northern New York State. W-3657.

CHIEF ENGINEER, graduate mechanical preferred. Must have experience and executive personality necessary to direct engineering design and development of all types of heat-transfer units, such as power plant, marine, chemical plant and refinery equipment. Permanent. $10,000-$15,000 year. N. Y. C. W-3692.

SALES ENGINEER, graduate mechanical, with experience in heat-transfer equipment. Should have acquaintance with users in this field and be able to direct sales campaign. Only top-notch man wanted. Permanent. Salary good, dependent upon qualifications of applicant. N. Y. C. W-3693.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after May 25, 1944, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ALLEN, RAYMOND F., Olean, N. Y.
ANDERSEN, JAMES R., Philadelphia, Pa.
ASMUSSEN, JES, Neenah, Wis. (Rt & T)
ATKINSON, ENBRY S., Erie, Pa. (Rt)
AUDE, THEODOR R., Tulsa, Okla.
BAEYERTZ, F. P., Henderson, Nevada
BAILEY, GEO. B., Michigan City, Ind.
BAILEY, WM. T., Kansas City, Mo.
BAKER, HENRY A., Whitestone, N. Y.
BARDACH, FELIX, New York, N. Y. (Rt & T)
BARKLEY, KENNETH L., Brevard, N. C. (Rt & T)
BEST, LUTHER SAML., Seattle, Wash. (Rt & T)
BOISCLAIR, HUGH C., Birmingham, Ala.
BRANNAN, JOHN C. (LIEUT.), Bremerton, Wash.
BROWN, ARTHUR H., San Francisco, Calif.
BURGESS, M. L., Omaha, Neb.
BURNS, FRANK D., Michigan City, Ind.
CATTANEO, A. G., Emeryville, Calif.
CHALLMAN, ARNOLD T. (LIEUT.), San Francisco, Calif.
CHRISTENSEN, BOYD, Wichita, Kan.
CHURGIN, LEOPOLD, New York, N. Y.
COFFIN, ROBT. S., Cleveland, Ohio
COLLIER, JOHN H., Chicago, Ill.
COOKE, THOMAS C., Durham, N. C. (Re)
COSTEN, LOUIS, Evanston, Ill.
COULTER, WARREN R., Toronto, Ont., Canada
CROOKS, WM. A., Independence, Mo.
CURTISS, H. C., Erie, Pa. (Rt & T)
DARLING, L. BRUCE, Rochester, N. Y. (Re)
DEL MAR, WALTER H., Chicago, Ill.
DE SELM, C. HILTON, Phoenix, Ariz.
DOWDELL, SAML. H., Hollywood, Fla.
FITZGERALD, R. M., JR., Freeport, Texas
FRANCIS, THOS. F., Kenmore, N. Y.
FREEMAN, G. F., New York, N. Y.
FRITTON, WM. J., 2ND, Kenmore, N. Y.
FRYLING, GLENN R., Philadelphia, Pa.
GIOIA, JOS. C., Brooklyn, N. Y.
GLOEKLER, ROBT. K., Erie, Pa.
GRAFF, PAUL T., Boston, Mass.
HALLBERG, ELMER E., Rockford, Ill.
HANKEN, GEO. H., St. Louis, Mo.
HARMUTH, J. T., Bridgeville, Pa.
HEILBERG, HERBERT, Natchez, Miss.
HILLIER, RONALD G., Gananoque, Ont., Canada
HOPEWELL, G. H., London, England
HUNTER, ANTHONY, Long Branch, N. J.
JOHNSON, RUSSELL K., New York, N. Y.
JUDD, MARCUS A., Milwaukee, Wis. (Re)
KAHLER, WM. G., South Charleston, W. Va.
KLAUS, J. W., St. Louis, Mo.
KOPP, PAUL J. (MAJOR), Washington, D. C.
LESTER, SAUL P., New York, N. Y.
LIPPINCOTT, J. GORDON, Scarsdale, N. Y.
LODEWYKS, P. F., Overland, Mo.
LONGFIELD, WM. F., Cleveland Heights, Ohio
LYLE, JAS. M., Louisville, Ky.
MAAG, J. M., St. Louis, Mo.
MAC MILLAN, G. D., Huntington, W. Va.
MAKHNO, VLADIMIR V., N.S.W., Australia
MANGOLD, WM. J., Allentown, Pa.
MANSKY, CLARENCE B., Ithaca, N. Y.
MARSHALL, DONALD E., Jersey City, N. J.
MARTIN, ROGER A., Atlanta, Ga. (Rt)
MATHEWSON, ROBT. C., Chicago, Ill.
MCHALE, WM. H., Indianapolis, Ind.
MCKEAND, MARSHALL L., Chicago, Ill.
MIDGLEY, JOHN M., Wichita, Kan.
MOSS, HOWARD K., Tarzana, Calif.
MUIR, JOHN N., Hamilton, Ont., Canada
MULHOLLAND, ROYE A., Austin, Texas
MULLAN, GEO. H., Kansas City, Mo.
NAGLE, PERRY, Chicago Heights, Ill.
NEFF, J. W., Easton, Pa.
NELSON, LAURENCE K., New Orleans, La.
OTZMANN, HENRY, JR., Newark, N. J.
PALMER, EDW. L., Glendale, Ohio (Rt & T)
PARKIN, ROBT. E., Rochester, N. Y.
PATTERSON, HARRY R., Cincinnati, Ohio
PINKUS, JEROME R., Oak Park, Ill.
PITRE, M. J., Huntington, N. Y.
PURDY, FRANK A., Portland, Ore.
QUICK, WM. K., Beloit, Kan.
QUINN, GEO. F., Chicago, Ill.
REIMULLER, PAUL E., Chicago, Ill.
ROSEN, ALBERT, Philadelphia, Pa.
ROTH, ROBT. J., Southbridge, Mass.
ROWE, HENRY A., Cambridge, Mass.
SKAWDEN, O. J., Bellefonte, Pa.
SMITH, FRANK W., Boston, Mass.
SMITH, HARRY W., JR., Philadelphia, Pa.
SOBEL, CHAS., New York, N. Y.
SPIEGELHALTER, WM. G., Erie, Pa.
TAWDUL, ADAM J., New York, N. Y.
TEPE, JOHN B., Chicago, Ill.
ULRICH, W. W., Hagerstown, Ind.
WALTON, X. O. A., Jamaica, N. Y.
VAN DEURSEN, CHAS. A., Key West, Fla. (Rt & T)
WALTON, EDWARD H., New Haven, Conn.
WILLCOX, JOHN F., Dallas, Tex. (Rt)
WOOD, JOHN B. (LIEUT.), Dayton, Ohio

CHANGE OF GRADING

Transfers to Member

AHRENS, HENRY R., JR., New York, N. Y.
ANDRIOLA, A. D., Drexel Hill, Pa.
BOEKELMAN, H. L., Chicago, Ill.
BRUGLER, M. W., New York, N. Y.
CASSOTTI, MARIO, New York, N. Y.
DELANO, RAYMOND P., JR., Baltimore, Md.
KOESTER, W. F., Wauwatosa, Wis.
LE TART, HAROLD J., Grand Haven, Mich.
MC EACHERN, JOE A. (MAJOR), New Orleans, La.
MOORE, THOS. G., Stamford, Conn.
SMITH, IRVINE W., Toronto, Ont., Canada

Necrology

THE deaths of the following members have recently been reported to headquarters:

CLEMONS, HENRY JENKINS, July 31, 1943*
FAIRFIELD, HOWARD P., December 2, 1943
GREENE, CHARLES EDWARD, March 8, 1944
LLOYD, CHARLES G., December 29, 1943
MCNAUGHTON, STEWART, December 14, 1943
NORMAN, ROY A., January 29, 1944
ORROK, GEO. A., April 6, 1944
OWENS, LOUIS J., February 13, 1944
STAPLES, EARLE I., January 15, 1944
SUTTON, WALTER CORNELL, March 10, 1944
VITTINGHOFF, HANS, May 25, 1943
WILLIAMS, ALBERT BLAKE, March 29, 1944
WITTE, FELIX, February, 9, 1944

* Died in line of duty.

A.S.M.E. Transactions for April, 1944

THE April, 1944, issue of the Transactions of the A.S.M.E. contains:

Analysis of Stretch-Forming Double-Curved Sheet-Metal Parts, by R. B. Glassco and N. O. Myklestad
Plastic Plywoods in Aircraft Construction, by R. D. Hiscocks
Pressure Loss in Elbows and Duct Branches, by Andrew Vazsonyi
Laboratory and Field Tests on Coal-in-Oil Fuels, by J. F. Barkley, A. B. Hersberger, and L. R. Burdick
Wear-Resisting Materials for Lathe Construction, by R. W. Dayton, C. H. Lorig, and R. E. Adams
Porous Chromium in Engine Cylinders, by Russell Pyles
High-Pressure Pipe-Line Research, by F. W. Laverty and F. M. McNall
Limiting Isothermal Flow in Pipes, by R. C. Binder